MADRAS GOVERNMENT MUSEUM.

Bulletin No. 3.

RÁMÉSVARAM ISLAND

AND

FAUNA OF THE GULF OF MANAAR.

SECOND EDITION, REVISED WITH ADDITIONS.

BY

EDGAR THURSTON, C. M. Z. S., ETC.,

Superintendent, Madras Government Museum.

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Madras Government Museum Bulletins.

No. 1.—Pearl and Chank Fisheries of the Gulf of Manaar.

No. 2.—Note on Tours along the Malabar Coast.

No. 3.—Rámésvaram Island and Fauna of the Gulf of Manaar.

No. 4.—Anthropology of the Todas and Kotas of the Nilgiri Hills (*in the Press*).

Nature.—"A series of Bulletins of the Madras Government Museum has been commenced by the Superintendent, Mr. Edgar Thurston, and Parts I and II, which have reached this country, contain much useful information upon the fisheries and marine zoology of the Presidency. Part I contains a revised account of the 'Notes on the Pearl and Chank Fisheries of the Gulf of Manaar'; and its subject-matter is already known in great part to British students of 'applied zoology.' Part II entitled 'Note on Tours along the Malabar Coast,' records a number of interesting observations in marine zoology made on the West Coast of Madras. It is interesting to note that even there the natives have their fishery question."

Calcutta Review.—Bulletin No. 1, Pearl and Chank Fisheries. "Wonderful is the quantity of information Mr. Thurston has deftly compressed within the 58 pages of what he modestly calls a Bulletin. Science, archæology, political economy, folklore, Sir Edwin Arnold's poetry, are all laid under contribution, and yet in every page the author's shrewd personality asserts itself. He makes a dull topic bright, and contrives to enliven the driest of details."

Indian Journal of Education.—In Bulletin No. 1 Mr. Thurston gives, in a very pleasant and readable form, an account of his visits to the pearl and chank fishing grounds of the Madras and Ceylon Governments. Those who take an interest in the commercial industries of India will find much valuable information. The naturalist too will discover much that claims his attention in these pages, for in a graphic and interesting way the writer has contrived to throw in a large number of facts relative to the fauna of the Gulf of Manaar.

"No one doubts that the seas, which lave our Indian Coasts, are abundantly stocked with edible fish, but the problem of making these vast resources available for the food supply of the half-fed masses of this country, has never yet been satisfactorily solved. We recommend Bulletin No. 2 to the attention of every thoughtful reader."

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Frontispiece.

E. THURSTON, PHOT. THE CALCUTTA PHOTOTYPE CO.

PAMBAN PASS.

I.—RÁMÉSVARAM ISLAND.

In January, 1887, it was my privilege to accompany the Secretary to Government, Public Works Department, and the Presidency Port Officer, Madras, on a tour of inspection of the light-houses, which come within the jurisdiction of the Madras Government, from Mangalore on the north-west round Cape Comorin to Gopalpur on the north-east. My knowledge of the littoral of the Madras Presidency was, apart from Madras, at that time confined to Rámésvaram island, on which a few days had been spent in 1886, and the west coast from Cochin to Trivandrum, which I had visited, with a view to making a collection of the fishes of Malabar, especially at Cochin, soon after my first arrival in India in 1885. Though the halts at the light-house stations were as a rule very short, this tour of inspection afforded me an excellent opportunity of forming a general idea as to the zoological capacity of the different parts of the coast. The specimens cast up on shore afford in some measure an index to the still living and submerged fauna of the neighbouring sea; and an examination of these, coupled with visits to the fish bazárs, enabled me to decide what parts of the coast were likely to afford the most profitable field for future investigation.

A casual non-scientific observer, walking along the sandy surf-beaten beach at Madras, will probably find nothing to attract his attention except a number of coarse shells destined for the manufacture of chunám (lime), an occasional flattened jelly-fish, and swift-footed crabs (*Ocypoda*) which, on the approach of man, scamper away, and disappear, like rabbits, into their burrows. But, if the same observer walks along the shore at Pámban, he cannot help noticing that, as shown in the frontispiece, it is strewn with broken fragments of dead coral, among which branches of madrepores are most conspicuous, and sponges washed on shore by a recent tide, or dried up above tide-mark. And, if he trusts himself upon the slimy blocks of coral which are exposed at low tide, and turns them over so as to display their under-

surface, he will find hidden there a wealth of marine animals —crabs, boring anemones, annelids, shell-fish, trepangs (*béches-de-mer*), and bright-coloured encrusting sponges. And the Madras beach may, allowing for differences of species, be taken as fairly representative of the coast of the Presidency, with the exception of the coral-fringed shores of the islands which skirt the coast of the gulf of Manaar, which I have visited on several occasions in the months of July and August. These months, though warm, proved very favorable, owing to the absence of rain, for carrying out investigations, and for the drying of specimens, *e.g.*, stuffed fishes, big sponges, and corals, such as are not suitable for preservation in alcohol or other fluid medium. Even, however, under the most favourable climatic conditions, the work of a marine zoologist beneath a tropical sun is, apart from the personal discomfort caused by the sun and glare on the water, except in the very early morning and towards sunset, attended by many difficulties, which are graphically described by Haeckel, who says,[1] speaking of surface-netting with a gauze tow-net:—"The wealth of varieties of marine creatures to be found in the Bay of Belligam was evident even on my first expedition. The glass vessels, into which I turned the floating inhabitants of the ocean out of the gauze net, were quite full in a few hours. Elegant *Medusæ*, and beautiful *Siphonophora* were swimming among thousands of little crabs and *Salpæ;* numbers of larvæ of mollusca were rushing about, mingled with fluttering *Hyaleadæ* and other pteropoda, while swarms of the larvæ of worms, crustacea, and corals, fell a helpless prey to greedy *Sagittæ*. Almost all the creatures are colorless, and as perfectly transparent as the sea-water in which they carry on their hard struggle for existence, which, indeed, on the Darwinian principle of selection, has given rise to the transparency of these pelagic creatures. But I soon discovered to my grief that, within a very short time after being captured, at most half an hour and often not more than a quarter, most of the fragile creatures died; their hyaline bodies grew opaque, and, even before we could reach the land, I perceived the characteristic odour exhaled by the soft and rapidly decomposing bodies."

Haeckel's experience is, unfortunately, not an uncommon one, and, while staying at Pámban, I frequently had the

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[1] *Visit to Ceylon.* Transl. by Clara Bell, 1883.

mortification of finding, on my return from a surface-netting expedition to the improvised laboratory at the Rája's bungalow, instead of a crowd of living animals, an amorphous mass composed of their corpses at the bottom of the collecting glasses. It is, in fact, essential for the preservation of many of the gelatinous pelagic organisms that they should, in this country, in the absence of an apparatus by which they can be supplied with a constant stream of cool water, be at once treated with the necessary fixing and preservative re-agents; but the management of the requisite processes is by no means an easy matter in the limited space afforded by a native dug-out (canoe). The suggestion made by Haeckel that the death and decomposition of the delicate organisms might be prevented by placing them in vessels cooled by ice is, without doubt, an excellent one; but unfortunately, ice cannot as a rule be procured in out-of-the-way places where one most requires it.

Among the pelagic organisms which I have collected over the coral reefs in the gulf of Manaar may be mentioned various small *Medusæ*, *Beroë*, *Cydippe*, *Bolina* (present one morning in such abundance that the net became instantly filled with a thick jelly), dense crowds of copepod and schizopod crustaceans sometimes rendering the surface of the water milky; *Zoœa*, *Phyllosoma*, and *Alima* larvæ; violet-blue *Janthinæ*; and *Styliola acicula*, a pteropod mollusc, whose dead glassy shells are very abundant in deposits from the sea bottom. Less frequently met with were young *cephalopods*, of which the adults, as well as a *chætopod* (*Nereis?*) obtained by digging deep holes in the sand, are extensively used as bait by the fishermen; *Salpæ;* and the ova and young of fishes. Floating, too, on the surface of the water, and conspicuous by their bright colouring, were various siphonophora—*Physalia* (the Portuguese man-of-war), *Velella* with its sundial-like crest, and *Porpita* with its exquisitely marked disc. Many minute pelagic animals were obtained by shaking in a tumbler of water the marine algæ which were floating over or living on the reefs, and of which the most conspicuous were *Sargassum vulgare* and *Padina pavonia* (peacock's tail). These pelagic organisms, from which the main food-supply of the coral polyps is probably derived, were far more abundant and varied over the Pámban reef during my visit to Rámésvaram island in 1886 than in 1888: and this is probably to be explained by the fact that, in the former

year, there was but little wind, and the water was so clear that, in the early morning before the gentle day breeze set in, the individual corals could be clearly distinguished as one rowed over the reef; whereas in the latter year there was generally a strong south-west wind blowing, and a rapid current running through the Pámban pass, carrying with it sediment in suspension, which rendered the water turbid: and, as is known, a pure and transparent condition of the water is the first and indispensable condition for the life of many marine creatures, especially those of the coast. Moreover, the ripple on the surface probably drove the pelagic animals into deeper water, which was not explored in search of them. On calm mornings, when the surface has been teeming with small *medusæ*, I have seen the living organisms and their dead gelatinous remains adhering in large quantities to the surface of greedy living coral polyps with their tentacles expanded, which were brought up for me by my divers. There has been a noticeable absence of big jelly-fishes during my visits to Rámésvaram Island. Only, in fact, during the last few days of my stay on the island in 1889 did I see a few large *rhizostomids* (called by the natives *sori*, i.e., nettles), floating over the reef or washed on shore. Phosphorescence, too, I have never seen well marked in the gulf of Manaar, the sight of an occasional luminous flash from a pelagic organism being the poor reward of night vigils.

The island of Rámésvaram, which is visited during the course of the year by enormous numbers of Hindu pilgrims from all parts of India to the celebrated temple, is separated from the mainland by the Pámban pass, which connects Palk's strait with the north end of the Gulf of Manaar, and is 1,350 yards in width. The depths in the channel range from 10¼ to 15 feet at low water, but it shoals up very suddenly on both sides, so that great care is necessary in navigating vessels through. "In the Pámban channel," Mr. H. S. Thomas writes in his *Rod in India*, "there are, or at least used to be some twenty years ago, a number of splendid runs. . . . . There was a fish there that we used to call the Pámban salmon, and were well content with the name. It turns out to be our mutual friend Polynemus."

On the west side of the pass is the great dam, consisting of large masses of sandstone, all having a more or less flat surface, which were formerly part of a causeway extend-

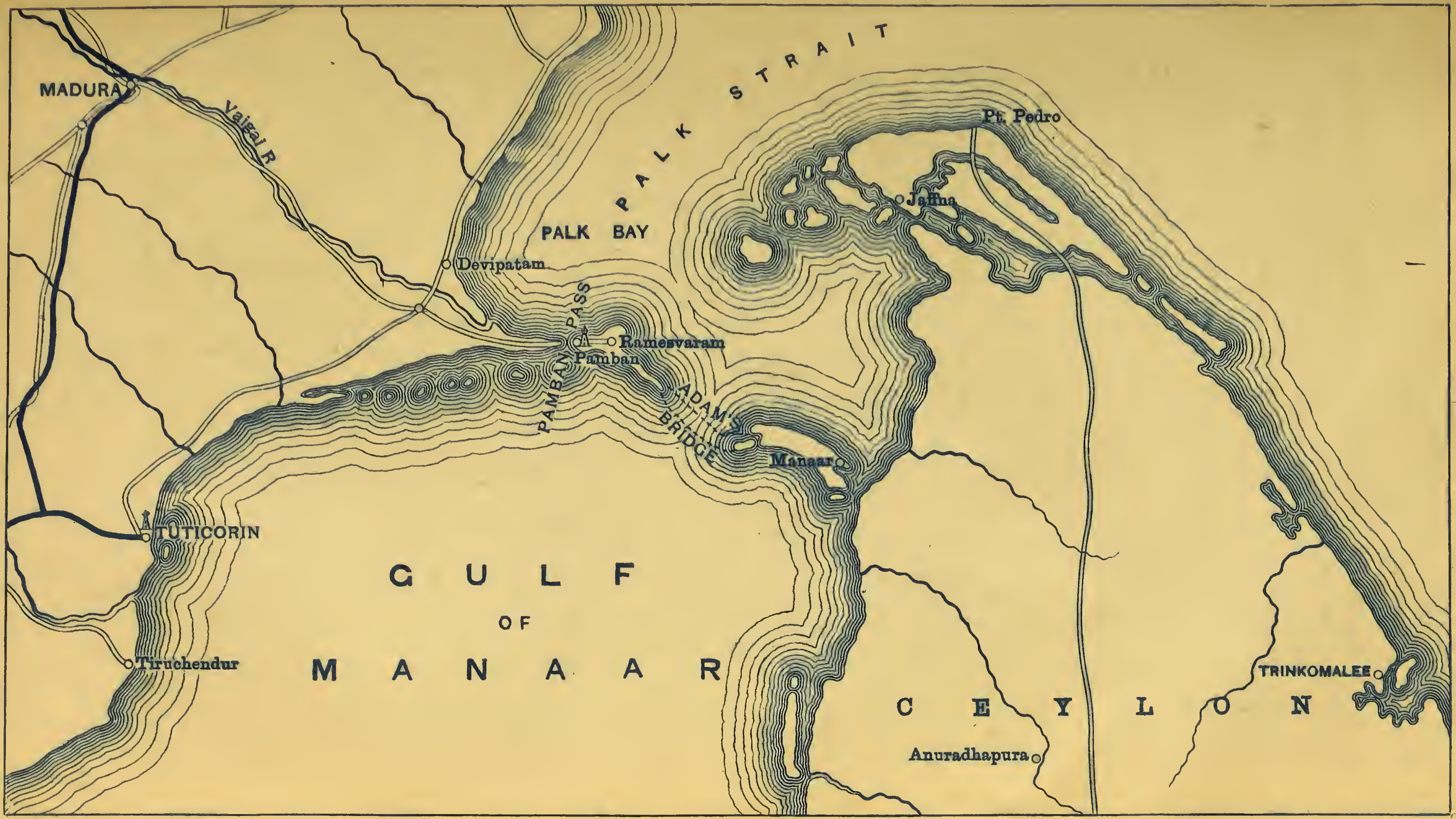

PHOTO-PRINT SURVEY OFFICE, MADRAS.
1895

ing from Rámésvaram Island across to the mainland. The remains of this causeway are still visible on the main road from Pámban to the town of Rámésvaram.

According to the folk-lore of the Hindus, the so-called bridge, which formerly connected Rámésvaram island with Ceylon, was built by an army of monkeys when Ráma made war against Rávana, who had, carried off his wife Sita to the island of Lanka (Ceylon), and as Mr. Bruce Foote observes: [2] "the series of large flat blocks of sandstone so strongly resemble a series of gigantic stepping-stones, that it is impossible to wonder at the imagination of the author or (in analogy with the Homeric epos) authors of the Ramayana that the rocky ridge was really an old causeway of human construction." A grotesque picture in Moor's 'Hindu Pantheon,' represents Hanumán assisted by Súgríva and their associates building the bridge. In connection with the building of the reef a story goes to the effect that the common South Indian squirrel (*Sciurus palmarum*) used to help the monkeys by rolling in the sand on the shore, so as to collect it in its thick hairy coat, and then depositing it between the piled up stones, so as to cement them together. At which service Ráma was so pleased that he stroked the squirrel on the back, which has, ever since, borne the finger marks.

Writing in 1821 concerning Adam's Bridge, Davy observes [3] that: "No one who looks at a map and notices the little distance (about 17 miles) between the nearest point of the island (Ceylon) and continent, and how, by the chain of rocks and sand-banks commonly called Adam's Bridge, they are still imperfectly connected, can entertain much doubt that the connection was once perfect. This inquiry is more curious than useful. It would be much more useful to endeavour to complete that which nature has begun, and to make the channel, which is now obstructed and dangerous, clear and safe, and fit for the purposes of coast navigation. If, on examination, sandstone and coral rock should be found constituting part of Adam's Bridge instead of primitive rock, one necessary inference is that the channel, at whatever period formed, was once deeper and more open than it is at present, and another inference is that, in process of time, it will be closed up, and Ceylon joined to the continent." The possibility of making an artificial union between

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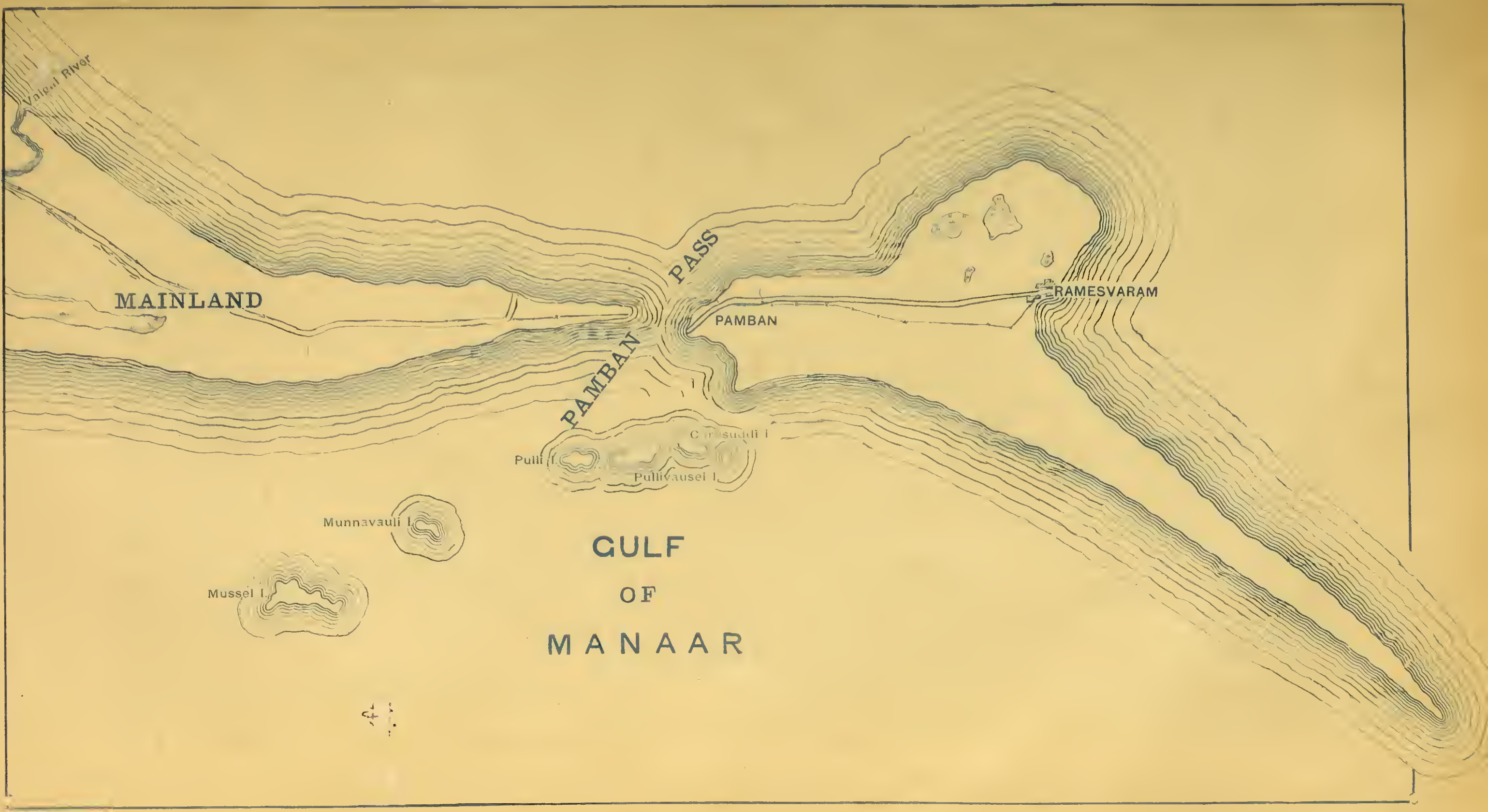
[2] *Mem. Geol. Surv., Ind.*, vol. xx, 1883. [3] *Travels in Ceylon.*

Southern India and Ceylon, by means of a railway across what remains of Adam's Bridge, is at the present time under discussion.

Tradition runs to the effect that, at the time of the disruption of Rámésvaram island from the mainland on the one side and Ceylon on the other, the cows became prisoners on the island, and being unable, like the cows at Cape Cod, which are fed on herring's heads, to adapt themselves to a fish diet, took to living on sea-weeds, and have become, by degrees, converted into diminutive 'metamorphosed cows,' which may still be seen grazing on the shore. This story is based on the fancied resemblance of the horned coffer-fishes (*Ostracion cornutus*), which are frequently caught in the fishing-nets, to cattle. Portions of the skulls of cats and dogs, including the articulated temporal, parietal, and occipital bones, which are sometimes picked up on the beach, also bear a rude resemblance to the skull of a cow, the horns being represented by the zygoma.

During the time of my stay at Pámban in 1888, a bucket dredger was at work in the pass, and from the mud brought up by it I obtained many small crustacea, echinoderms (chiefly *Laganum depressum* and *Fibularia volva*), mollusca (of which *Leda mauritiana* was one of the most abundant) including great quantities of the little *Avicula vexillum*, which was formerly mistaken for the young of the pearl-oyster, a gephyrean (*Dendrostoma signifer*), *Branchiostoma* (*Amphioxus*), and many fragments of a small *Fungia*, which must be very plentiful, but of which I have never obtained a perfect specimen.

Southward of the Pámban pass are three islands, Pulli, Pullivausel, and Coorisuddy, completely encircled by an irregular coral reef, the whole forming a natural break-water protecting the pass and the channels leading to it from the violence of the south-west winds. The space between the northern edge of this reef and the pass forms a fine sheltered anchorage for vessels of light draft in all weathers. The deepest water between the above islands and the pass is immediately south of Coorisuddy, and is called the basin, over which there is an average depth of 18 feet, but in one spot there is a depth of 21 feet. This basin is, however, very narrow, being simply a hole scoured out by the action of the water in rushing through the pass: and, consequently, is of little value to ships, as it has the pass to the northward of it with only 10 feet, and



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1895

the sand-bank channel to the southward with only 9½ feet at low water. The tides are very irregular at Pámban, the rise and fall being much affected by the winds. The average springs rise 3 feet; but, during neaps, sometimes for 48 hours, there is frequently only a rise and fall of 1 or 2 inches. The currents are generally influenced by, and strong in proportion to the force of the wind. Through the Pámban pass the current frequently attains to a velocity of from 5 to 6 knots an hour, rendering it at times difficult even to take full-powered steamers through. During the north-east monsoon the current sets to the north through the pass. The only months in which a real tidal current is noticeable are March, April, and October, when it generally sets six hours each way. No records of the temperature of the water over the reef are extant, and, as my visits have always been at the same season, extending over only a few weeks of the year, the temperature observations which I have made are practically of no value. The following table, however, shows the maximum and minimum and monthly range, recorded at the Pámban marine office in the shade at 10 A.M. and 4 P.M. during the twelve months from April 1st, 1888, to March 31st, 1889. The range of temperature during that period will be seen to be from 76° to 92°, *i.e.*, 16°:—

——	Minimum.	Maximum.	Range.
April, 1888	81°	92°	11°
May „	79°	91°	12°
June „	84°	88°	4°
July „	84°	89°	5°
August „	84°	88°	4°
September, 1888	84°	89°	5°
October „	78°	89°	11°
November „	78°	89°	11°
December „	77°	86°	9°
January, 1889	76°	81°	5°
February „	80°	88°	8°
March „	82°	92°	10°

The town of Pámban is situated on the western extremity of the island, and lies to the west and south-west of the light-house, built on the top of a sand-hill, at the foot of which is a good example of sand-rock, *i.e.*, a mass of fine sand, which has become compacted by the action of wind

and spray, so as to form a stratified friable rock exposed amid the surrounding loose blown sand. With the exception of the Port officer's house and a few others, the houses consist principally of huts made of *cajan* leaves. The native population is mainly made up of boatmen and fishermen, some of whom find employment in carrying coolies over to Ceylon, and others in ferrying the pilgrims bound for the témple at Rámésvaram from the mainland to the island. There are also a large number of coolies, who are engaged in hauling vessels through the pass when the wind is adverse.

Pámban boasts of a ruined fort built by the Dutch during their occupation of the island, over which I was taken by a native guide, who pointed out as objects of interest some stone cannon-balls, battered dredge-buckets of modern construction, and some barrels of fuse lying mouldering from age in what he termed a *conji* (gruel) house, a damp, ill-ventilated building, wherein, at some period at which the Public Works Department was engaged on works in the island, the recalcitrant sapper used to be placed in confinement on a sedative *conji* diet.

As regards the food-supply at Pámban, beef and mutton are not easily procurable, goat, long-legged and emaciated, being the principal animal supplied. Fowls and native vegetables can always be obtained in the bazár. The local eggs possess a peculiar flavour which is attributed to the fact that the fowls feed partly on fish, affording an example of polyphagy. One is reminded of the observation of John Hunter, that a species of gull (*Larus tridactylus*), though commonly feeding on fish, and having its stomach adapted to flesh diet, can also live on grain. Another species of gull (*Larus argentatus*) is said to live in the Shetland islands on grain in the summer and on fish in the winter. The fish supply at Pámban is very plentiful, and a visit to the ill-smelling fish bazár always showed an abundance of fish, unappetising cephalopods, and crustacea (*Neptunus pelagicus*, *Scylla serrata*, *etc.*) which make excellent curries, for sale. During my visit in 1889 the following food-fishes were obtained either by means of a dragnet or from the bazár :—

SHARKS AND RAYS.

Zygæna malleus, *Shaw.*
Trygon uarnak, *Forsk.*
Myliobatis nieuhofii, *Bl. Schn.*

Pl. V.

E Thurston, Phot. The Calcutta Phototype Co.

SHORE AT RÁMÉSVARAM.

BONY FISHES.

Lates calcarifer, *Bloch.*
Lutjanus rivulatus, *Cuv. & Val.*
Lutjanus roseus, *Day.*
Therapon theraps, *Cuv. & Val.*
Pristipoma hasta, *Bloch.*
Scolopsis, sp.
Gerres oyena, *Forsk.*
Drepane punctata, *Gmel.*
Scatophagus argus, *Bloch.*
Upeneoides tragula, *Richardson.*
Upeneus indicus, *Shaw.*
Lethrinus nebulosus, *Forsk.*
Teuthis oramin, *Günth.*
Caranx ire, *Cuv. & Val.*
Caranx speciosus, *Gmel.*
Equula edentula, *Bloch.*
Sillago sihama, *Forsk.*
Mugil speigleri, *Bleeker.*
Cynoglossus macrolepidotus, *Bleeker.*
Arius thalassinus, *Rüpp.*
Saurida tumbil, *Bloch.*
Hemiramphus xanthopterus, *Cuv. & Val.*
Clupea, sp.
Pellona leschenaultii, *Cuv. & Val.*

My head-quarters on the island have been mainly fixed at the bungalow of the Sétupati of Ramnád, the head of the Maravars, on whose behalf I once had to appear in the Madura Court, and stand the fire of cross-examination in connection with the coinage of his ancestors on the throne of the Sétupatis (Lords of Adam's bridge). The bungalow is situated on the summit of a sand hill near the Pámban light-house, and would make an excellent marine biological station, easy of access from Madras now that between Negapatam and Pámban there is a service of coasting steamers, of light draft so as to be able to get through the shallow channel of the Pámban pass.

Occasionally my camp has been pitched on the shore at Rámésvaram close to the spot where the pilgrims, under the directions of a priest, go through a course of mysterious ceremonies and ablutions, and deposit in the sea pice and clay images, the former of which are subsequently searched for by the poorer classes.

As pointed out by Dr. Walther, in the extension of the reef band towards the Rámésvaram temple, appears a limestone consisting entirely of calcareous algæ (*Lithothamnium*), with a few scattered coral masses. This extensive deposit is represented on plate V, the back-ground of which is made up of palmyra palms.

The verandah of the Rája's bungalow affords a good spot for the study of the common animals and birds of the island. The former consist mainly of ill-conditioned pariah dogs; goats trying to extract the requisite amount of food stuffs for the maintenance of life from dried palmyra leaves

and the leaves of the umbrella thorn (*Acacia planifrons*), the thorns of which serve as no protection against the attacks of these hard-mouthed herbivorous mammals; and donkeys suffering from motor paresis of their hind limbs. The shrill voiced palm squirrel and musk shrew ('musk-rat') infested the bungalow, and a friendly mungoose made repeated visits when I was at breakfast. Of birds, the splendid but shameless crow (*Corvus splendens* or *impudicus*) made continual raids on my specimens drying in the sun; and parakeets screaming in a neighbouring fig tree, and screech-owls making night hideous with their domestic quarrels, proved a constant source of irritation. Beneath the Acacia trees were large numbers of bleached land-shells, which were identified for me by Dr. O. Boettger as being:—

Buliminus (Rhachis) punctatus, *Ant.*
Buliminus (Mastus) chion, *Pf.*
Helix (Eurystoma) vittata, *Müll.* (small form).
Helix (Trachia) fallaciosa, *Fér.*
Hemiplecta lixa, *Blf.*
Xesta ceylanica, *Pf.*

As regards *Xesta ceylanica*, Dr. Boettger writes to me:—"I am not in possession of original specimens of Blanford's species from the foot of the Anaimalai hills, but I cannot find a difference in the diagnosis. It is a next ally to *H. gardneri* of Ceylon and *H. shiplayi* of the Nilgiris."

During my stay on the island in 1886 the following birds were shot by my shikaree:—

Tinnunculus alaudarius, *Briss.* Kestril.
Micronisus badius, *Gm.* Shikra.
Athene brama, *Tem.* Spotted owlet.
Merops viridis, *Linn.* Common Indian bee-eater.
Palæornis rosa, *Bodd.* Rose-headed parrakeet.
Brachypternus aurantius, *Linn.* Golden-backed woodpecker.
Xantholæma indica, *Lath.* Crimson-breasted barbet.
Hierococcyx varius, *Vahl.* Common hawk cuckoo.
Coccystes melanoleucos, *Gm.* Pied-crested cuckoo.
Centropus rufipennis. Common coucal ('crow pheasant').
Upupa nigripennis, *Gould.* Indian hoopoe.
Lanius erythronotus, *Vig.* Rufous-backed shrike.
Lanius vittatus, *Val.* Bay-backed shrike.
Dicrurus ater, *Herm.* Black drongo.
Crateropus griseus, *Gm.* White-headed babbler.
Pycnonotus luteolus, *Less.* White-browed bulbul.
Molpastes hæmorrhous, *Gm.* Madras red-vented bulbul.
Œgithina tiphia, *Linn.* Common iora.

Copsychus saularis, *Linn.* Magpie robin.
Corvus macrorhynchus, *Wagl.* Jungle crow.
Corvus splendens, *Vieill.* Indian house crow.
Acridotheres tristis, *Linn.* Common myna.
Temenuchus pagodarum, *Gm.* Black-headed myna.
Turtur suratensis, *Gm.* Spotted dove.
Tringa minuta, *Leister.* Little stint.
Phœnicopterus roseus, *Pallas.* Flamingo.
Xema brunnicephala, *Jerdon.* Brown-headed gull.
Seena aurantia, *Gray.* Large river tern.

On the sandy shore of Shingle island, one of the islands which intervenes between Rámésvaram island and the mainland, which is overgrown with long grass reaching in some places to a height of six feet, my friend Mr. J. R. Henderson saw, in early June, hundreds of a doubtful species of tern (?) and a few of the large river tern (*Sterna seena*). Of these the latter laid a single egg in a tunnel excavated among the matted roots of the grass, and artfully concealed from view. The former laid a single egg in a hole scooped out in the sand near the water's edge, where the grass was either very short or absent; and the eggs were easily missed owing to the resemblance between their colour and that of the sand, which affords an example of the adaptation of the coloring of eggs to their natural surroundings for the purpose of concealment, according to the principle of protective coloration. In July, 1888, the shores of Coorisuddy island were in possession of an army of occupation of flamingoes, which were, no doubt, feeding on annelids and burrowing crabs.

On Coorisuddy Island the following botanical specimens were collected :—

Ærua javanica, *Juss.*
Bœrhavia diffusa, *Linn.* Spreading hog-weed.
Clerodendron inerme, *Gærtn.*
Cynodon dactylon, *Pers.* Hariáli grass.
Dodonæa viscosa, *Linn.*
Enicostema littorale, *Blume.* The *chota chiretta* of natives.
Eugenia jambolana, *Lam.* Black plum.
Euphorbia corrigioloides, *Boiss.*
Ipomæa biloba, *Forsk.* One of the most important sand-binding plants.
Launæa pinnatifida, *Cass.* A common plant of the sandy coasts.
Oldenlandia umbellata, *Linn.* Chay-root or Indian madder.
Pandanus odoratissimus, *Willd.* Screw-pine. Recommended by Cleghorn as a very strong sand-binder.
Pemphis acidula, *Forst.*

Phyllanthus niruri, *Linn.*
Salvadora persica, *Linn.* Tooth-brush tree; said by Royle to be the mustard tree of the Bible.
Suæda monoica, *Forsk.*
Vernonia cinerea. Ash-colored flea-bane. One of the commonest Indian weeds.

The palmyra palm (*Borassus flabelliformis*) grows very abundantly on Rámésvaram island, and the prepared fibre is exported to Ceylon. The method of preparation [4] consists in detaching from the trunk of the tree the lower part of the leaf which remains clinging to the tree after the leaf has been cut off or dried, beating this with a wooden hammer, and pulling out the fibre which is detached. The best trees for the purpose are said to be young ones from 12 to 15 feet high. The stalks require to be in a certain and particular state of decay, in which the fibre when hammered out will be of a black colour. The white fibre which is obtained from immature stalks is less pliable and more brittle, and fetches an inferior price in the market. The chief objection to palmyra fibre for brush manufacture is that it lacks straightness; but, if this defect could be overcome, it is claimed that palmyra should be found equal to the best Brazilian piassava fibre.

The insect world, apart from the irrepressible ants and mosquitoes, is only poorly represented on Rámésvaram Island, and of lepidoptera the most conspicuous was *Papilio* (*Menelaides*) *hector*, flying swift-winged along the shore or far out at sea. The following common species of lepidoptera were captured in July, 1889 :—

Mycalesis mineus, *Linn.*
Melanitis leda, *Linn.*
Tarucus plinius, *Fabr.*
Catochrysops strabo, *Fabr.*
Catopsilia crocale, *Cramer.*
Catopsilia catilla, *Cramer.*
Terias hecabe, *Linn.*
Papilio hector, *Linn.*
Papilio erithonius, *Cramer.*

Though I have met with none myself, I have been shown a collection of scorpions (*Scorpio swammerdami*) which were captured at Pámban.

A big spider belonging to the genus *Mygale* (*M. fasciata?*) concerning the bird-eating propensities, of which genus there has been a long-standing controversy,[5] was caught by me when developing photographs in an impro-

[4] Report by the Head Assistant Collector, Madura District, 1892.
[5] See *Journ., Bombay Nat. Hist. Soc.* vol. i, 1886, p. 28.

Pl. VI.

E. Thurston, Phot. The Calcutta Phototype Co.

FOSSIL REEF, PÁMBAN.

vised dark room at the Rája's bungalow. Soon after my arrival in Madras, in 1885, a live female *Mygale* was sent to me from one of the districts of the Presidency, on the charge of killing sheep and goats by poisoning them on the muzzle, with a request that I would convict or acquit the accused on experimental evidence. A sheep was accordingly purchased, and the *Mygale* placed in a gauze net which was tied over the sheep's muzzle. For a short time the *Mygale* strolled about, showing no indication of poisonous intent, and then—the sheep put out its long tongue and swallowed her, bringing the experiment to an abrupt termination.

The shells of *Cerithia*, which adhere in dense masses to the reef rock at Pámban, are collected by poor women, and burnt into chunám (lime) in a simple kiln on the shore, fed by a fire obtained by burning drift-wood, seeds, cocoanut husks, etc., which are thrown up on the beach by the in-flowing tide.

Commencing near the Rája's bungalow, and extending for some distance along the north coast of the island, is a sub-fossil coral reef, which I cannot do better than describe in Mr. Bruce Foote's words:[6] "The upraised reef," he says, "is a striking feature of the north coast of Rámésvaram Island, and is worthy of much closer study than the time at my disposal enabled me to bestow upon it. It shows best along the beach beginning a couple of hundred yards west of the zemindar's bungalow, where it forms a little irregular scarp about a yard or 4 feet high, against the roof of which the waves break in rough weather. Of its true coral reef origin there can be no doubt, as in many places the main mass of the rock consists of great globular meandroid corals, or of huge cups of a species of Porites which, beyond being bleached by weather action, are very slightly altered, and still remain in the position in which they originally grew. The base of the reef is not exposed, as far as I could ascertain, not having been sufficiently upraised along the beach; but in a well-section a little to the south of the Gandhamána Parvattam chattram the thickness of the coral reef exposed above the surface of the water is at least 10 feet, and probably much more. The great swampy flat forming the northern lobe, as it were, of Rámésvaram Island, consists, I believe, entirely of this upraised reef hidden only by a thin coating of alluvium, or the water

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[6] *Mem. Geol. Surv., Ind.*, vol. xx, 1883.

of the brackish lagoons which cover the major part of the surface, but do not form a continuous sheet of water as shown in the map. I came across masses of coral protruding at intervals through the alluvium in the very centre of the flats north-westward of the great sand-hill crowned by the chattram just named. The raised reef is very well seen to the north-eastward of Rámésvaram town, where it forms a miniature cliff from 3 to 4, or possibly 5 feet high, and continuing along the coast after the latter turns and trends to north-west. Time did not admit of my actually following it up to Pesausee Moondel point, but I went to within a mile of the point, and could see no change of character of the coast line on examination through a strong field-glass. The raised reef shows strongly also along the western side of the flat north wards of Ariangundu. The south side of the reef is, along the north coast, completely covered up by the great spreads of blown sands which occupy the greater part of the surface of the island. On the east side of the island the reef does not extend close up to the great temple, but stops short abruptly about 300 yards to the north-east, and does not re-appear on the coast of the bay south of the temple. South of Pámban town also there were no signs of any upraised coral, nor could I see any indication eastward along the south coast, as far as the eye could reach from Coondacaul Moondel point, while the great south-east spit terminating at the point called Thunnuscody is covered by a double ridge of great blown sand-hills. An important series of trial sinkings made by the Port officer at Pámban right across the island, from north to south, about 2 miles east of the town, in order to test the feasibility of the proposed ship canal, did not reveal any southerly extension of the raised reef. The probability is that it forms a mere narrow strip along the beach from Pámban to Ariangundu, but widens out thence to the north-eastward to form the northern lobe of the island. Parts of the reef lying between collections (colonies as it were) of the great globular or cup-shape coral masses form a coarse sandstone made up of broken coral, shells, and sand (mostly silicious) a typical coral sandstone. At the Pámban end of the raised reef it shows a slight northerly dip, and masses of dead coral, apparently *in situ*, protrude through the sand below high water mark. Reefs of living coral fringe the present coast, but these I was unable to examine, so cannot say whether the corals now growing there are specifically allied to those

Pl. VII.

E. THURSTON, PHOT.

THE CALCUTTA PHOTOTYPE CO.

FOSSIL REEF, PÁMBAN.

which formed the reef now upraised, but all the mollusca and crustacea I found occurring fossil in the latter belong to species now living in the surrounding sea." Mr. Bruce Foote writes further:—" It is quite evident from the occurrence of the old coral reef on Rámésvaram Island that the latter must have been upraised several feet within a comparatively recent period, but unfortunately there are no data by which to calculate the exact amount of the upheaval. The upheaval which affected Rámésvaram island doubtless affected the adjoining mainland, and, by upraising the coast, exposed the sandstones, which have been described above as forming a low wall-like cliff bordering the beach as if by a built quay."

A good specimen of a sandstone quay wall is to be seen on the mainland between the great dam and Muntapum; and north of Kílakarai, a town on the coast south-west of Rámésvaram Island, a very perfect wall of sandstone extends for some distance along the shore, in the loose sand covering which many copper coins—Roman, Choḷa, Páṇḍyan, Dutch, Indo-French, etc., have been found in recent years. The area which intervenes between the fringing coral reef and the sloping shore at Kílakarai, and which is uncovered by water at low tide, is covered by an extensive green carpet formed by a dense growth of *Zoanthi* agglutinated together by damp sand, among which small isolated madrepores live, though periodically exposed to the heat of the sun. That the coral polyps do not die when thus exposed is due, as pointed out by Möbius and confirmed by Walther, to the fact that they secrete during low ebb-tide a great deal of viscid mucus, which covers the whole corallite and protects it from drying up. I have frequently noticed that the massive blocks of *Porites*, *Cœloria*, &c., brought to me by the divers were long after their removal from the sea covered with a slimy secretion, beneath which the polyps were alive, as evidenced by their movements of contraction and expansion.

Opposite the town of Kílakarai there is a wide gap in the reef, through which sailing boats of light draft can pass into the shallow harbour within the reef, on which the force of the leaves is broken. The calcareous alga, *Halimeda opuntia*, forms a thick deposit on the sea bottom, in shallow water, among the coral patches off Kílakarai. This species is, Mr. G. Murray writes to me, " one of the most abundant siphoneous algæ in all warm seas Atlantic, Mediterranean, Indian Ocean. It is green when growing, and turns white

when cast up. I have found it in the West Indies forming a thick layer at tide-mark, cast up in bays into which a strong current runs."

Possessing only very superficial geological knowledge, I am unable to deal satisfactorily with the sub-fossil reef at Pámban, which has, however, more recently than Mr. Bruce Foote's report, received full justice from the pen of Dr. Walther.[7] Commencing, as already stated, near the Rája's bungalow, it forms a wall exposed to a height of 3 or 4 feet above the sandy shore in which it is imbedded, and extending, almost without interruption, for a distance of a quarter of a mile, after which it becomes covered over with loose sand, and is exposed only at intervals. The main mass of this wall, as also of the big detached coral blocks which intervene between it and the sea, and are washed by high tides, is built up of enormous blocks of *Porites,* one of which, isolated from neighbouring blocks, has a diameter of 12 feet. That these blocks are imbedded as they grew is shown not only by their reef-like appearance, but also by their upright position, the vertical columns of many of the blocks bearing testimony to the fact that they have not been cast up by the waves at random, like the big coral fragments which are exposed at low tide, and lie irregularly in all possible unnatural positions. The calices on the surface of the fossil corals are either perfectly distinct over large areas, so as to render their identity certain, or, especially in the case of the blocks which are still exposed to wave action, worn away, or concealed by a crystalline incrustation. Imbedded in cavities in the *Porites,* once bored and occupied by the living mollusc animal, are immense numbers of the shells of the lithodomous *Venerupis carditoides,* which abounds on the living reef at the present day. The *Porites* are frequently capped by *Astræans,* which are also found firmly fixed to their lateral aspect. Less commonly they are incrusted with *Mæandrinas* (*Cœloria*), which, like the *Astræans,* also form solid isolated blocks, but of far smaller size than the *Porites.* The blocks are, for the most part, covered on their upper surface by a crust of thick compact laminated sand-rock, imbedded within which are the shells of mollusca—*Cardium, Arca, Turbo, Cerithium, Spondylus, Corbula, Trochus, Cypræa,* &c. I

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[7] Vide *Verhandlungen der Gesellschaft für Erdkunde zu Berlin,* 1889, No. 7, translated in Rec. Geol. Surv. Ind., vol. xxiii, pt. 3, 1890; and *Petermann's Mitteilungen aus Justus Perthes' Geographischer Anstalt Ergänzungsheft,* No. 102, 1891.

have also found several carapaces of fossil decapod crustacea, whose genus I was unable to identify. At the commencement of the reef, *i.e.*, at the end nearest to the bungalow, the sand-rock is arranged in a succession of layers with a dip seawards, and forms an incrusting layer about 8 inches thick. A little further on the reef has a terraced appearance; an upper terrace being formed by sand-rock horizontally stratified, exposed to a height of 18 inches, and supported by underlying *Porites*, *Astræa*, *Cœloria*, and *Turbinaria*; and a lower terrace formed by a flat-topped mass of *Porites*, about 9 yards in length, covered with loose sand. Not the least interesting feature of the coral wall is the presence of a bank of madrepores, extending over a length of 8 yards at a higher level than the *Porites*, and evidently still placed as they originally grew, their radiating branches spreading outwards from the base, and forming a broad flat surface, which affords support to a thick superjacent layer of consolidated sand-rock. The maximum height of the madrepores above the loose shore sand is 18 inches, and they clearly form a portion of a bank, such as may be seen spreading over considerable areas on the living reef on a calm day.

As one looks out to sea from the Pámban bungalow at low water on a breezy day, three distinct zones can be clearly distinguished, viz.:—(1) commencing about three-quarters of a mile from the shore, and extending to the horizon, clear blue water separated by a sharp line of demarcation from (2) a zone discolored by sediment in suspension carried by the current through the Pámban pass. This zone, in which the living corals flourish though washed by a current, sometimes running at the rate of 7 to 8 knots per hour, to which they are exposed, terminates at the sharply defined land face of the reef,[8] where the corals, constantly bathed by water and never exposed above the surface, act as a natural breakwater which breaks the force of the waves, so that, at high tide, the shallow water between the reef and the shore is smooth. The land face of

[8] In the third edition of Darwin's *Structure and Distribution of Coral Reefs*, the reefs of the Madras Coast of the Gulf of Manaar and the northern part of Ceylon are not indicated on the map (in which by the way an active volcano is indicated near Negapatam) showing the distribution of coral reefs, because as Professor Bonny says (p. 247):—"The sea off the northern part of Ceylon is exceedingly shallow, and, therefore, I have not colored the reefs which partially fringe portions of the shores and the adjoining islets, as well as the Indian promontory of Madura."

the reef is made up almost entirely of madrepores, amid a perfect forest of arborescent sea weeds and fleshy alcyonians which, as one rows over the reef on a bright still morning, can be easily recognised as large snow-white patches. Other genera—*Porites*, *Cœloria*, *Turbinaria*, etc.—occur in deeper water. (3) There is a zone, about 40 yards in breadth, between the reef and the shore, which is covered by water at high tide, but completely exposed at low tide. It is made up of dead coral blocks, fragments, and débris, among which branches of worn madrepores are most conspicuous, broken off or rolled along from the reef. These blocks and fragments are covered with low-growing clumps of brown and green sea weeds, and enclose shallow pools in which 'coral fishes' of brilliant hue may be seen, and colonies of *Cerithia* leaving in their wake a characteristic track. Many of the larger coral blocks are extensively worn by the process of solution, or eroded by boring mollusca and other animals. Among the crevices of the eroded corals various crustacea (*Gonodactylus*, *Pilumnus*, &c.), find a home ; and crawling on their surface, which is frequently covered by erect or sessile encrusting sponges, or hidden beneath them, annelids (*Amphinome*, *Nereis*, &c.), and bright-colored planarians may be found.

From the Pámban beach the sea bottom slopes very gradually to a depth of 20 to 26 feet at a distance of three-quarters of a mile from the shore. Between the Kathoo Vallimooni reef, marked on the survey chart as being 'partially dry at low water spring tides,' and the spit of mainland which terminates at Point Rámen a boat passage has been carved out by natural processes. North of Rámésvaram island the living coral reef formation is stated by the local fishermen, in answer to independent inquiries by Mr. Bruce Foote and myself, to extend only as far as Pillay Mudum, 7 miles south-east of the Vigai river, which, though easily crossed on foot in the dry season, is in high flood during the monsoon, and, for about a fortnight in the year, impassable even on a raft.

Piled up over a limited area at the base of the fossil reef were masses and fragments of pumice [9] encrusted with

[9] "The fragments of pumice thrown up into the ocean during far distant sub-marine eruptions, or washed down from volcanic lands, are at all times to be found floating about the surface of the sea, and there being cast upon the newly formed islet produce by their disintegration the clayey materials for the formation of a soil, the red earth of coral islands." Murray, Royal Institution, March 16, 1888.

Polyzoa, Chamæ, tubes of tubicolous worms, *Balani*, young pearl-oysters, &c. In all probability these fragments were, in the first instance, discharged from the volcano of Krakatoa during the great eruption of 1883. One curious result of that eruption was that, in the district of Charingin, which was depopulated by the tidal wave during the outburst, tigers increased so enormously in number that the Government reward for killing them had been fixed at 200 guilders each.

Washed on shore by the waves, protecting the upper surface of the dead corals, or brought up for me from the sea bottom by my divers, were nodular calcareous algæ, which, from microscopical examination, I find to be identical with those which were dredged off the town of Negombo in Ceylon by Captain Cawne Warren, and reported on by Mr. H. J. Carter.[10] "The specimens," says that authority, "consist of calcareous nodules of different sizes, which may be said to originate, in the first instance, in the agglutination of a little sea bottom by some organism into a transportable mass which, increasing after the same manner as it is currented about, may finally attain almost unlimited dimensions. They are, therefore, compounded of all sorts of invertebrate animals, whose embryoes, swimming about in every direction, find them, although still free and detached, of sufficient weight and solidity to offer a convenient position for development, and hence the number of species in and about them. . . . . Perhaps no family of organisms has entered into their composition or increased their solidity more than calcareous algæ (*Melobesiæ*) which, in successively laminated or nulliporoid growths, have rendered these nodules almost solid throughout, or covered with short, thick, nulliporiform processes. . . . . . . Next to the part which the *Melobesiæ* have taken in their formation may be mentioned the sessile *Foraminifera*, and these have, in turn, been overgrown, in many instances, by *Polyzoa*."

Specimens have been picked up on shore both by Mr. Bruce Foote and myself of a curious body, the nature of which has given rise to some discussion, and is still and likely to remain *sub judice*. One of them was exhibited at the Linnean Society, and Dr. Anderson and Mr. Dendy were inclined to regard it as possibly the consolidated roe of a fish; whereas Professor C. Stewart was of opinion that

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[10] *Ann. Mag. Nat. Hist.*, June, 1880.

it was a vegetable structure; his opinion being based on the examination of microscopical preparations which he demonstrated to me when I was in Europe some time ago.

Among other specimens collected on the Pámban beach I may mention the complex tubular skeletons of the chætopod *Filograna*, and large blocks of drift wood bored by the mollusca *Teredo* and *Parapholas*, the latter of which had destroyed the bottom of the local port gig.

The Indian fin-whale (*Balænoptera indica*), concerning which I overheard a visitor to the Madras museum explaining to his son that it uses the whale-bone as a tooth-brush, has been known to accompany vessels in the gulf of Manaar, and I have seen one close to a steamer in which I was rounding Cape Comorin. It is related that, some years ago, the schooner 'Abdul Ráman,' which was at anchor close to Pámban, was suddenly released from her moorings, and towed out to sea to a distance of several miles by some invisible agent. A few days afterwards the carcase of a whale was cast on shore, and the theory was that this whale was the cause of the involuntary cruise, it having been tempted out of curiosity to examine the ship, in whose grapnel it is supposed to have been caught, and to have taken the steamer in tow until it liberated itself. In support of this theory, the ribs and vertebræ of a whale were shown to me in the grounds of the mission bungalow.

The phytophagous Sirenian, *Halicore dugong* (the dugong), which is said [11] to be found in the salt-water inlets of South Malabar, feeding on the vegetable matter about the rocks and basking and sleeping in the morning sun, is according to Emerson Tennent [12] attracted in numbers to the inlet from the Bay of Calpentyn on the west coast of Ceylon to Adam's Bridge by the still water and the abundance of marine algæ in this part of the Gulf of Manaar. It is of an extremely shy disposition, and I have never seen it myself, though I have heard of dead carcases being thrown up on the Pámban beach, and living specimens being caught in the fishing nets. One was, in fact, caught, together with a young one, the day before my arrival at Pámban in 1889, and promptly sold for food, as it is considered a great delicacy. There is a tradition among the natives that a box of money was found in the stomach of a dugong which was cut up in the Pámban bazár some years ago; and an official

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[11] Jerdon, *Mammals of India.*

[12] *Ceylon*, vol. ii, 1860.

is now always invited to be present at the examination of the stomach contents, so that the possessors of the carcase may not be punished under the Treasure Trove Act for concealing treasure. But the stomach contents invariably prove to be green sea-grasses (phanerogams) which are very abundant in the shallows of one to three feet in depth on the Ceylon coast of the gulf of Manaar, and almost entirely exclude the sea weeds (algæ). The fat of the dugong is believed to be efficacious in the treatment of dysentery, and is administered in the form of sweetmeats, or used instead of *ghi* (clarified butter) in the preparation of food. The skeleton of a female dugong in the Madras museum shows, encased in the upper jaw, the functionless teeth, the blunt points of which are, during life, covered by a fleshy lip forming a snout. The female is described by Tennent (*op. cit.*) when suckling her young, as holding it to her breast with one flipper, while swimming with the other, holding the heads of both above water, and, when disturbed, suddenly diving and displaying her fish-like tail.

The divers brought me from one of the neighbouring islands a single specimen of the hawk's bill turtle (*Chelone imbricata*), the source of tortoise-shell, and the edible turtle (*Chelone mydas*). The latter I have seen carrying the cirrhiped *Chelonobia testudinaria* [13] and the pearl-oyster attached by its byssus to the carapace. It is very abundant in the shallow water near the sandy shores of the islands in the vicinity of Râmésvaram, on which the female lays her eggs. A large specimen, whose skeleton has been preserved, was purchased for eight annas on the understanding that the vendor should have the flesh as a perquisite. The process of removal of the edible portions of fat, flesh, and viscera was not a pleasant operation to witness. The victim was placed on its back, and secured by ropes which did not prevent demonstrative flapping of its fins during the operation. The operation, skilfully performed with a carving knife, of removal of the breast-plate displayed the internal organs, which were removed together with their investing fat. The pulsations of the heart, which was removed last of all, the snapping of the jaws, the plaintive expression of the eyes, and general indications of disapproval formed a ghastly spectacle not easily to be forgotten. The flesh of the edible

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[13] I have also seen parasitic pedunculated cirrhipeds attached to the skin of a sea-snake (*Hydrophis*), the gills, of *Neptunus pelagicus*, and the antennæ of *Panulirus dasypus*.

turtle is described by Tennent as being sold piecemeal in the market place at Jaffna, while the animal is still alive, each customer being served with any part selected which is cut off and sold by weight; and Darwin, referring to the gigantic tortoise of the Galapagos Archipelago, says that, when a tortoise is caught, a slit is made in the skin near the tail, so as to see whether the fact under the dorsal plate is thick. If it is not, the animal is liberated, and it is said to soon recover from the minor surgical operation.

A single specimen of the fresh-water tortoise (*Nicoria trijuga*), which I recently heard referred to as a "trot-ice", found at the foot of a tree on the sandy soil outside the town of Pámban, was brought to me for sale. The land snakes of the island are represented, so far as I know, from personal observation, by *Lycodon aulicus* and *Tropidonotus stolatus,* of which the latter bit a friend's native servant in the foot, causing great torture until he was assured that it was not a toxicophidian. Batrachians I have not seen on the island, but the existence of *Rana hexadactyla,* which is, I am told, eaten in the Indo-French possessions, was made evident by the nocturnal concerts in a tank near the bungalow. Frogs are eaten by some of the lowest caste natives in India, and by the Burmese. In the bazárs of Burma boiled frogs are exposed for sale among other articles of food. I have myself seen dried frogs hung up for sale in the Cochin bazár.

One of the edible holothurians [14] (*trepangs* or *béches-de-mer*) is very abundant in the mud on the south shore at Pámban, and in the vicinity of Rámésvaram, at both which places it is prepared for exportation to Penang and Singapore. The process of preparation, which is not an appetising one to watch, is as follows:—The holothurians are collected as they lie in the mud at low water, and placed in a cauldron which is heated by a charcoal fire. As the temperature rises in the cauldron, the still living animals commit suicide by the convenient process of ejecting their digestive apparatus, &c., and become reduced to empty leathery sacs which, by loss of water consequent on the temperature to which they are exposed, shrivel considerably. At the end of twenty minutes or half an hour the boiling process is stopped, and the shrivelled animals are buried in the sand until the following morning, when the

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[14] *Holothuria marmorata.*

boiling process is repeated. Finally, they are arranged according to their size, and are ready for shipment.

Trepangs, of which various kinds are recognised in commerce, are highly esteemed as an article of food by Chinese and Japanese epicures, being made into a thick gelatinous soup. They are said to be a favorite article of diet among the colonists of Manilla, and to make a capital dish when cooked by a European chef.

As regards the question [15] whether holothurians live on living coral or obtain nutriment from swallowing the sand and detrital material, the two most abundant species in the Gulf of Manaar (*H. atra* and *H. marmorata*) live, not on the reef, but on the muddy bottom between the reef and the shore, which is frequently uncovered at low tide. From repeated examination of the contents of their alimentary canal, I have been unable to find any evidence that they have been feeding on living coral, the swallowed materials consisting, for the most part, of sand, coral débris, small mollusca, alcyonian spicules, and sea weeds.

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[15] *Vide* Darwin, *Coral Reefs*, 3rd edition, 1889, p. 20.

II.—LITTORAL FAUNA OF THE GULF OF MANAAR.

THE gulf of Manaar, bounded on the north by Adam's bridge, intervenes between the west coast of Ceylon and the south-east coast of the Madras Presidency. The greatest depth yet found, and recorded by Dr. A. Alcock, when Surgeon-Naturalist to the Marine Survey Steamer 'Investigator,' in the more open part of the gulf, is 1,466 fathoms (temperature 34·8° Fahr.), and the bottom appears to be green mud throughout.

It is earnestly to be hoped that both the littoral and deep-sea fauna of the gulf will some day receive, through the medium of a biological station worked on lines similar to those of the Naples and Plymouth stations, the exhaustive investigation which they richly deserve. The time at my own disposal, and the diffuse work of Museum direction, which necessitates residence in Madras during the greater part of the year, have so far permitted only an occasional flying visit, such as renders any attempt at exhaustive observations wholly out of the question, and I am consequently only able to place on record lists, with some details, of those species which have been obtained by myself from Rámésvaram and the neighbouring islands, from Tuticorin, and, in the case of the crustacea and mollusca, from the Ceylon pearl banks and their vicinity.

My hearty thanks are due for the great assistance which they have rendered in working out my collections, to Mr. A. Dendy (sponges), Dr. Ortmann (corals), Dr. Selenka (gephyrea), Professor Jeffrey Bell (echinoderms), Mr. J. R. Henderson (crustacea), Dr. Von Martens and Mr. E. A. Smith (mollusca) and Mr. R. Kirkpatrick (bryozoa).

PORIFERA.

The sponges recorded below were collected by me either in the neighbourhood of Rámésvaram island or at Tuticorin, and sent to Mr. A. Dendy, at that time on the staff of the British Museum, Natural History, by whom they were described in detail in the *Annals and Magazine of Natural History*, September, 1887, and February, 1889.

As regards the first collection, which was made at Rámésvaram, Mr. Dendy wrote as follows :—" The collection is of exceptional interest, owing to the fact that it is the first which has been obtained from this particular locality. Indeed our knowledge of the sponge-fauna of the entire Indian ocean is extremely deficient. This deficiency is almost certainly due to want of investigation rather than to any actual scarcity of sponges. Mr. Ridley and I have already pointed out, in our report on the Monaxonida collected by H.M.S. Challenger, that 'this little-known field will probably yield a rich harvest to whoever has the good luck to thoroughly investigate it;' and this statement is amply borne out by Mr. Thurston's researches.

" The best known locality for sponges in the Indian Ocean is undoubtedly Ceylon. Bowerbank, Gray, and Carter have all written upon the sponge-fauna of this particular district, and the sponge-fauna of Madras, in so far as is evidenced by the material at my disposal, bears a striking resemblance to it. Thus, out of the ten determinable species from Madras, four, viz., *Halichondria panicea* (a cosmopolitan species), *Axinella donnani*, *Hircinia clathrata*, and *Hircinia vallata*, have already been recorded from the neighbourhood of Ceylon.

" There can be no doubt that the present collection was obtained in shallow or moderately shallow water, although there is no record of the depth. Species with a strong development of spongin in the skeleton-fibre predominate, as might have been safely predicted from the climatic conditions of the locality."

The majority of the sponges, as will be seen, belong to the monaxonida, which " comprise by far the most commonly met with and abundant of all sponges. They occur in greater or less profusion in all parts of the world, but are more especially shallow-water forms. They may be collected between tide-marks almost anywhere." [16]

None of the gulf of Manaar sponges, which I have collected from between tide-marks up to 11 fathoms, are of any commercial value. [17] The colours of many of them are very bright, but soon fade or change when the sponge is dried or immersed in alcohol.

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[16] Challenger Report on Monaxonida.

[17] A single small specimen of the commercial sponge, *Spongia officinalis*, was collected by Dr. Anderson in the Mergui Archipelago.

The following list includes only a portion of my collection, many of the sponges still awaiting identification. Of the thirty-one species recorded by Mr. Dendy, eighteen (indicated by an asterisk) were described as new species, and two new varieties of previously recorded species, viz., *Pachychalina multiformis* and *Ciocalypta tyleri.*, were described.

TETRACTINELLIDA.

* Tetilla hirsuta, *Dendy*. Tuticorin. Pale yellow with darker centre.

MONAXONIDA.

Halichondria panicea, *Johnston*, var. Rámésvaram. Light pink variety of the British species.
Petrosia testudinaria, *Lamarck*, sp. Tuticorin pearl banks. Pink, cup-shaped.
* Reniera madrepora, *Dendy*. Tuticorin. Pink.
* Pachychalina multiformis, *Lendenfeld*, sp. (var. manaarensis, *Dendy*). Tuticorin. Pale violet, or light pink.
* ,, delicatula, *Dendy*. Tuticorin. Colour not recorded.
* ,, spinilamella, *Dendy*. Tuticorin. Pale yellow.
Siphonochalina communis, *Carter*, sp. Tuticorin. Bluish brown.
* Gelliodes carnosa, *Dendy*. Tuticorin. Grey.
Iotrochota baculifera, *Ridley* (var. flabellata, *Dendy*). Rámésvaram and Tuticorin. Dark purple.
Tedania digitata, *Schmidt*, sp. Rámésvaram. Red.
* Clathria indica, *Dendy*. Tuticorin. Frequently incrusting pearl oyster. Bright red.
* ,, corallitincta, *Dendy*. Tuticorin. Coral-red.
* Rhaphidophlus spiculosus, *Dendy*. Tuticorin. Vermilion.
* Hymeniacidon ? fœtida, *Dendy*. Tuticorin. Grey; smells like valerian when dry.
* Phakellia ridleyi, *Dendy*. Rámésvaram. Red.
Ciocalypta tyleri, *Bowerbank* (var. manaarensis). Tuticorin. White.
* Acanthella carteri, *Dendy*. Tuticorin. Orange.
* Auletta aurantiaca, *Dendy*. Tuticorin. Orange-red.
Axinella donnani, *Bowerbank*. Rámésvaram and Tuticorin pearl banks. Orange.
* ,, labyrinthica, *Dendy*. Tuticorin. Red.
* ,, tubulata, sp. *Bowerbank*. Rámésvaram and Tuticorin pearl banks. Inhabited by commensal tubicolous oligochœte worms. Pinkish-red or red.

* Raspailia fruticosa, *Dendy*. Rámésvaram. Pink.
* ,, thurstoni, *Dendy*. Rámésvaram. Dry shore specimens.
* Suberites inconstans, *Dendy*. Between tide-marks. Pámban.
,, *a* var. mœandrina. Brown. Canal system of var. mœandrina inhabited by ophiuroids.
,, *β* var. digitata.
,, *γ* var. globosa.

CERATOSA.

* Spongionella nigra, *Dendy*. Tuticorin. Black.
Hippospongia, sp. Rámésvaram.
Hircinia clathrata, *Carter*. Rámésvaram and Tuticorin. Canal system occupied by a cirrhiped crustacean, *Balanus* (*Acasta*) *spongites*.
* ,, vallata, *Dendy*. Rámésvaram.
Aplysina purpurea, *Carter*. Tuticorin. Grey (in spirit, or when dry); dark purple.
,, fusca, *Carter*. Tuticorin.

CŒLENTERATA.

OCTACTINIA.

Alcyonium digitulatum, *Klünz*. Rámésvaram.
,, gyrosum, *Klünz*. Rámésvaram.
,, polydactylum, *Ehr*. (var. mamillifera, *Klünz*). Rámésvaram.
Sarcophytum pauciflorum, *Ehr*. Rámésvaram.
Echinogorgia pseudosasappo, *Köll*. Rámésvaram; also from the Madras harbour; studded, as figured by Esper, with Aviculæ, and ophiuroids.
,, sasappo, *Köll*. (*Esper* sp.). Rámésvaram.
,, cerea, *Köll*. Rámésvaram; also from the Madras harbour.
,, furfuracea, *Köll* (*Esper*, sp.). Rámésvaram; also from the Madras harbour.
Plexaura flabellum, *Esper*. Horny axes cast on shore at Rámésvaram and Tuticorin.
Juncella juncea, *Pallas*. Rámésvaram and Tuticorin (near shore and on pearl banks).
Gorgonia (Leptogorgia) miniacea, *M. Edw*. (*Esper*, sp.). Ramésvaram and Tuticorin.
Gorgonella umbella, *Esper*. Tuticorin.
Suberogorgia suberosa, *Pallas*. Rámésvaram and Tuticorin.
Corallium nobile, *Pallas*. Rámésvaram.

Pteroides javanicum, *Bleeker*. Rámésvaram.
,, esperi, *Herklots*. Rámésvaram and Tuticorin.
Virgularia juncea, *Esper*. Rámésvaram.
Lituaria phalloides, *Pallas*. Rámésvaram.

Some of the alcyonia formed large, flat, encrusting masses. Entwining their arms round the stems and branches of *Juncella juncea, Suberogorgia suberosa*, etc., were delicate ophiuroids (*Ophiothix*, etc.), and, clinging to the gorgoniæ were the crinoids, *Antedon reynaudi, Antedon palmata*, and *Actinometra parvicirra*. Living on the stems of the red-coloured gorgoniæ I several times found the mollusc *Ovulum* (*Radius*) *formosus*, the colour of whose shell corresponded with that of the gorgoniæ.

A specimen of *Suberogorgia suberosa*, obtained at Mauritius in 90 fathoms, is described by Ridley (*Ann. Mag. Nat. Hist.*, 1882, p. 132) as "an immense dry specimen 3 feet 5 inches high, and 18 inches in maximum lateral diameter. The colour is pale wainscot to pale rufous-brown; the branches are given off mostly at angles of 30. The colour, very different from the deep brick-red usual in this species, may perhaps be due to the manner of drying." The height of a specimen in the Madras museum from Tuticorin, where the pale and brick-red varieties were living side by side, is 4 feet 8 inches, and the maximum lateral diameter 2 feet 2 inches. The specimens of *Gorgonia miniacea* were characterised by the almost constant presence, on the stems or at their bifurcation, of diseased excrescences—the so-called galls—occupied by a cirrhiped crustacean, and perforated by an orifice, through which currents of water for the respiration of the crustacean were admitted into the cavity of the excrescence, through which the stream passed in a constant direction. The association of similar excrescences on stony corals of the genera *Sideropora, Seriatopora*, and *Pocillopora*, is discussed in detail by Semper, and I have myself seen a specimen of the cup-shaped *Turbinaria crater* (preserved in the Madras museum), the interior surface of which presents a mammillated appearance caused by hundreds of *Balani*. Several fragments of *Corallum nobile*, the red coral of commerce, have been picked up by me on the Pámban beach, and the native divers tell me that they occasionally come across much larger pieces. Concerning this species Ridley says [19]:— "Dr. Lankester

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[18] Animal Life. *Internat. Science Ser.*, vol. xxxi.
[19] *Ann. Mag. Nat. Hist.*, vol. xi, 1883.

(Uses of Animals to Man), besides the Persian Gulf, gives Ceylon as a locality for this, the precious red coral of the Mediterranean and Cape Verd Islands, and Dr. Ondaatje has shown me decorticated specimens from Ceylon, which make the identity of the species probable. It is noteworthy that a fossil form is recorded from Indian deposits (Duncan), which, as I have given reasons for thinking (Proc., Zool. Soc., 1882, p. 334), seems probably identified with this species, Seguenza having found it fossil in India, still bearing a slight red tint. 'An officer,' in a work entitled *Ceylon* (London, 8vo., 1876) mentions small fragments of red coral similar to that of the Mediterranean as having been found at the water's edge between Galle and Colombo, and states it to have been referred to by the Portuguese." It must be borne in mind, however, that the red coral of commerce is imported to the east in large quantities to be worked up into necklaces and other ornaments for natives; and it is possible that the small fragments, picked up from time to time on the beach, may be only adventitious products, and not a natural product of the neighbouring sea. The condition of the Indian trade in red coral has been said [20] to be an accurate gauge of the condition of the agricultural classes in the North-Western Provinces, Rajputana and Sub-Himalayan tracts, as the bulk of the imports is brought by these classes to be worn as necklaces, the coral beads, when a man is prosperous, alternating with gold beads. The value of the red coral imported into India in the years 1889–92 was Rx. 140,194; Rs. 1,68,716 and Rs. 1,08,112, respectively.

VIRGULARIA JUNCEA. [21]

My attention was directed to an article in the *National Review*, February, 1890, entitled 'Out of the Depths,' by the Honorable A. E. Gathorne-Hardy, who there enters into a discussion of the habits of the genus Virgularia. The points at issue are two-fold :—

(1) Do the animals stand up vertically with their bulb planted in the mud ?

(2) Can the animals pull themselves in with force so as to nearly or quite disappear ?

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[20] J. E. O'Conor. *Review of Indian Trade*, 1882–83.

[21] This note was originally published in the *Proc. Zool. Soc., Lond.*, June 17, 1890.

In the first edition of my *Notes on Pearl and Chank Fisheries*, I said with reference to specimens of Virgularia : "The Sea-pen, *Virgularia juncea*, accords in its habits with another species, *V. patagonica*, which is described by Darwin (*Journal of Researches,*) as being seen projecting like stubble with the truncate end upwards, a few inches above the surface of the muddy sand. When touched or pulled, they suddenly draw themselves in with force so as to nearly or quite disappear."

The specimens of *V. juncea* were obtained by one of my Labbi divers in shallow water opposite the Kothanda Raman kovil (temple) on Rámésvaram island in July, 1888. His attention was attracted by what he thought was a stick projecting a few inches above the sandy bottom, and he broke it off and gave it to one of my native collectors, who was with him and recognized it as being the broken piece of an animal. The divers then hunted for and secured numerous other specimens, all of which had their terminal bulbs in a perfect condition. The largest specimen was 16 inches in length, and tapered towards the upper end, but the extreme tip was wanting. The diver described the animals as sticking straight up in the sand, and said that, as soon as he touched them, they went deeper and deeper down in the sand, and sometimes fixed themselves so firmly that he could only secure them by digging them out with a spade.

Though I was not present at the capture of the specimens, I had no reason to discredit the evidence of the diver who was a keen observer, wholly unacquainted with the English language, and who had certainly never seen or heard of the Journal of Researches.

HEXACTINIA.

Actiniaria.

Various undetermined species of sea-anemone are found, either burrowing in the sandy shore between tide-marks, or attached to, or living within cavities excavated in coral blocks. A single specimen of *Palythoa tuberculosa*, recorded by Esper from Tranquebar on the east coast of the Madras Presidency, was brought up by the divers at Pámban, encrusting the upper surface of a dead coral. Various species of *Zoanthus*, single or colonial, live among the corals

on the reefs. At both Tuticorin and Pámban I have several times seen specimens of *Sphenopus marsupialis,* which was collected originally by Johns, a Moravian Missionary, at Tranquebar, and was during the cyclone of 1886 cast on shore in very large numbers at Madras, where it was collected for me by one of my native taxidermists, who reported to me that he found it 'grazing' on the beach. The outer surface of this species is made up of sand grains glued together by a viscid secretion and imbedded in a cartilaginous case. Specimens figured in the *Proceedings of the Zoolcgical Society*, February 14, 1867, were collected at Pulo Faya in the China seas.

MADREPORARIA.

1. Madreporaria Aporosa.

Fam. *Turbinolidæ.*

Paracyathus profundus, *Duncan.* (Fauna Mergui).

Fam. *Pocilloporidæ.*

Pocillopora bulbosa, *Ehrbg.*
,, verrucosa, *Ell. Sol.*

Fam. *Astræidæ.*

Galaxea bougainvillei, *Blott.*
,, ellisi, *M. Ed. and Haime.*
Symphyllia radians, *Val.*
Echinopora aspera, *Ell. Sol.*
,, flexuosa, *Verrill.*
,, lamellosa, *Esper.*
Leptoria gracilis, *Dana.* var. tenuis, *Dana.*
Cœloria arabica, *Klzg.*
,, ,, var. subdentata, *M. Ed. and Haime.*
,, ,, var. leptotricha, *Ehrbg.* (= C. bottai, *M. Ed. and Haime.*)
Hydnophora contignatio, *Försk.* (=H. Ehrenbergi, *M. Ed. and Haime.*)
,, lobata, *Lmk.*
,, microconus, *Lmk.*
Favia clouei, *Val.*
,, denticulata, *Ell. Sol.*
,, cf. tubulifera, *Klzg.*
Goniastræa halicora, *Ehrbg.*
,, retiformis, *Lmk.*

Prionastræa tesserifera, *Ehrbg.*
Plesiastræa, cf. versipora, *Lmk.*
Phymastræa, n. sp., *Ortm.*
,, profundior, *M. Ed. and Haime.*
,, valenciennesi, *M. Ed. and Haime.*
Cyphastræa mülleri, *M. Ed. and Haime.*
,, serailia, *Försk.*
Merulina ampliata, *Ehrbg.*

II. Madreporaria Fungida.

Fam. *Plesiofungidæ.*

Siderastræa savignyana, *M. Ed. and Haime.* Identical with S. sphœroidalis, *Ortm.* (steinkor, v. Ceylon), which is only another form of growth.
Tichoseris obtusata, *Quelch.*

Fam. *Cycloseridæ.*

Cycloseris cyclolites, *Lmk.*

III. Madreporaria Perforata.

Fam. *Eupsammidæ.*

Cœnopsammia ehrenbergiana, *M. Ed. and Haime.*
Heteropsammia cochlea, *Spengler.*

Fam. *Madreporidæ.*

Madrepora corymbosa, *Lmk.*
,, erythræa, *Klzg.*
,, formosa, *Dana.*
,, multiformis, *Ortm.*
,, plantaginea, *Lmk.*
,, cf. secunda, *Dana.*
Turbinaria crater, *Pall.*
,, ,, var. quincuncialis. *Ortm.*
,, mesenterina, *Lmk.* var. cinerascens, *Ell. Sol.*
,, peltata, *Esp.*
Astreopora pulvinaria, *Lmk.*
Montipora exserta, *Quelch.*
,, foliosa, *Pall.*
,, spongiosa, *Ehrbg.*
,, stylosa, *Ehrbg.*

Fam. *Poritidæ.*

Porites columnaris, *Klzg.*
,, lutea, *M. Ed. and Haime.*
,, solida, *Försk.*
Goniopora pedunculata, *Quoy and Gaim.*

The majority of these stony corals belong to the class of "reef corals," but a few species are included, *e.g.*, *Paracyathus profundus*, *Cycloseris cyclolites*, and *Heteropsammia cochlea*, which were dredged in deep water, where the reef-builders were absent, and the young *Fungiæ*, which were dredged from the muddy bottom of the Pámban Pass. All the specimens of *Heteropsammia cochlea* exhibited a hole bored by a sipunculid worm (*Aspidosiphon*),[22] which is always found living within this coral. It is difficult, as Semper points out,[23] to understand what advantage each animal can derive from their association; yet some must exist, for a coral is never found without a worm.

The fact is drawn attention to by Dr. Martin Duncan, in his report[24] on the madreporaria of the Mergui Archipelago collected by Dr. Anderson, as being very remarkable that "the coral-fauna of Ceylon, so far as it is known from Mr. Stuart O. Ridley's researches, does not contain a single Mergui species. The number of genera common to the two areas is, however, great, and many species are closely allied." A comparison of the list of species recorded above from the Indian side of the gulf of Manaar with those of Dr. Duncan (Mergui),[25] Dr. Ortmann[26] and Mr. Ridley[27] (Ceylon) shows, as might be expected, that some of the species are common to the Indian coast of the gulf of Manaar and Ceylon, and others to the Indian coast of the gulf of Manaar and the Mergui archipelago.

I have found no representative of the hydrocorallinæ on the coral reefs, but *Millepora dichotoma* has been recorded by Ridley (loc. cit) from Ceylon.

The genus *Heliopora* is apparently not represented on the living reef, but a single specimen of *Heliopora edwardsana* has been described from the cretaceous deposits of the

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[22] See note on commensal sipunculid inhabiting the genus Heteropsammia, by G. H. Fowler, Q.J.M.S., No. CXX, Feb. 1890, pp. 412–13.
[23] *Animal Life. Internat. Science Ser.*, 1881.
[24] *Journ. Linn. Soc.*, Nov. 13, 1886.
[25] *Faun. Mergui. Archipelago*, vol. i, 1889.
[26] *Zoologisch Jahrbuch, Spengel*, vol. iv, 1889.
[27] *Ann. Mag. Nat. Hist.*, Ser. 5, vol. xi, 1883.

Trichinopoly district of the Madras Presidency, concerning the coral-beds of which Stoliczka writes:—[28] "The conditions of the deposits were not so quiet that we could expect to find any of the alcyonaria or of the malacodermata preserved, but the sclerodermata or madreporaria are represented by fifty-seven species, namely, fifty-three belonging to the *aporosa*, three to the *perforata*, and one to the *tabulata*. . . . . . Looking at the whole fauna we see the reef-building *Astræidæ*, *Stylinidæ*, and *Thamnastræidæ* much exceeding the other families in numbers of species, as well as in frequency of occurrence of specimens. Coral reefs appear to have been of considerable extent, particularly along the old shores within the Ootatoor group; in the two other groups they were much more local."

The method employed by me for the preservation of corals (*i.e.*, the skeletons) which I reserve for exhibition, is to expose them to the action of the sun and ants, which remove a large amount of the animal matter, and send them in boxes, surrounded by paper and tightly packed in rice-husk, by native sailing boat to Madras. But, however great the care which is taken, it generally happens that some of the corals become covered with mould during the voyage. The rice-husk, which is usually found clinging to the surface of the corals, is removed with a syringe, and the corals, after being submitted to repeated washings with fresh-water, are finally dried in the sun. In no case are they submitted to the action of corrosive alkali solutions. It has been objected, with regard to the preservation of corals by exposing them for some time to the action of rain or running water, that the finest details of the skeleton are liable to be dissolved away to some extent by the action of the carbonic acid in the water. But I found, on my visit to Rámésvaram island in 1889, when enormous numbers of a species of beetle were busily engaged in heaping up finely divided sand between the branches of my rejected madrepores, that the structural details of various delicate corals (*Astræopora*, *Cyphastræa*, *etc.*), which I had left discarded on the sand in the grounds of the bungalow twelve months previously, were to no appreciable extent damaged for purposes of identification, though they had, in the interval, been freely exposed to the action of a heavy monsoon and a cyclone. I am told that the corals rejected by me, as being too

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[28] *Palæont. Ind. Cretaceous Fauna of Southern India.*

numerous for transport to Madras, have been a source of income to my divers, who offer them for sale to stray visitors to the island.

HYDROIDA.

Plumularidæ.

Halicornaria bipinnata. Muttuvartu par, Ceylon.
,, insignis, *Allman.* Muttuwartu par, Ceylon.
,, saccaria, *Allman.* Muttuwartu par, Ceylon.

Campanularidæ.

Campanularia juncea, *Allman.* Abundant on east Chéval par, Ceylon.

ECHINODERMATA.

A report on a collection of echinoderms, which I made in the years 1886–87 at Rámésvaram island and Tuticorin, by Prof. F. Jeffrey Bell, was published in the *Proceedings of the Zoological Society,* June 19, 1888, wherein the writer states that " I may be allowed to remind the student of the recent appearance of a memoir on the echinoderm-fauna of the Island of Ceylon.[29] Shortly after the distribution of that memoir my respected correspondent, M. de Loriol, was kind enough to write and tell me of four other species of Echinoids, all of which had been collected at Aripo by M. Alois Humbert." Of these four species (*Phyllacanthus annulifera, Temnopleurus reynaudi, Clypeaster humilis,* and *Laganum depressum*), *C. humilis* and *L. depressum* have been found by me off the Indian coast of the Gulf of Manaar.

Only two new species have been discovered among my collections, viz., an ophiuroid, *Pectinura intermedia,* and an asteroid, *Oreaster* (*Pentaceros*) *thurstoni,* of which the latter is a very common shallow-water species, very variable both in its characters and colour. Since the publication of Prof. Bell's report several species, not recorded there, have been found in my subsequent visits to the gulf of Manaar, bringing the total number up to sixty-one.

The majority of the specimens were found in shallow water near the shore, but some, *e.g., Oreaster* (*Pentaceros*) *lincki, Linckia lævigata, Colochirus quadrangularis,* and *Astrophyton clavatum* (of which a single imperfect specimen

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[29] *Scientific Transactions of the Royal Dublin Society* (2), III, p. 643 *et seq.*

was found within the cup of a *Turbinaria*) were brought up by divers from the pearl banks in ten to eleven fathoms.

Of the six species of echinoid which are described by Agassiz, in his 'Revision of the Echini' as being characteristic of his Indo-African Region, which includes the Madras coast, five, viz., *Echinodiscus auritus* and *biforis*, *Salmacis sulcata* and *bicolor*, and *Echinolampus oviformis*, are very abundant in the gulf of Manaar. But I have not as yet found the sixth species, *Echinodiscus lævis*.

The fossil echinodermata, as recorded in the *Palæontologia indica* from the cretaceous deposits in South India, are represented by two or three species of crinoidea (*Pentacrinus* and *Marsupites*), a single species of asteroid (*Ophiura ? cunliffei*), and thirty-eight species of echinoidea, of which the genera *Cidaris* and *Hemiaster* are most largely represented.

CRINOIDEA.

Antedon cumingi. Tuticorin.
,, palmata, *Müll.* sp. Pámban and Tuticorin. In crevices of coral or on *gorgoniæ*.
,, reynaudi, *Müll.* sp. Pámban. On stems of *gorgoniæ*.
Actinometra parvicirra, *Müll.* sp. Tuticorin. On stems of *gorgoniæ*.

ASTEROIDEA.

Astropecten hemprichii, *M. Tr.* Pámban. A specimen in the Madras Museum has swallowed a mollusc, *Cerithium*.
,, polyacanthus, *M. Tr.* Pámban.
Luidia hardwickii, (*Gray*), *Perrier.* Pámban.
,, maculata, *M. Tr.* Pámban.
Goniodiscus granuliferus, (*Gray*), *Perrier.* Pámban.
Anthenea acuta, *Perrier.* Pámban.
,, pentagonula, (*Lmk.*), *Perrier.* Pámban.
Pentaceros muricatus, *Linck.* Tuticorin pearl banks.
,, superbus, *Möbius.* sp. Tuticorin.
,, thurstoni, *Bell.* sp. Pámban, Tuticorin.
Asterodiscus elegans, *Gray.* Tuticorin.
Asterina cepheus, (*M. Tr.*), *V. Mart.* Pámban.
Linckia miliaris, (*Linck*), *V. Mart.* Tuticorin pearl banks.
Nardoa novæ caledoniæ, *Perrier.* sp. Tuticorin.
Echinaster purpureus, (*Gray*), *Bell.* Tuticorin.

OPHIUROIDEA.

Pectinura gorgonia, *Ltk.* Pámban.
,, intermedia, *Bell.* Pámban.
,, infernalis, *Ltk.* Tuticorin.
Ophiactis savignii, *Aud.* Pámban. In canal system of sponge *Suberites inconstans.*
Ophionereis dubia, *Lym.* Tuticorin.
Ophiocoma erinaceus, *M. Tr.* Pámban.
Ophiothrix longipeda, *M. Tr.* Pámban
,, nereidina, *M. Tr.* Pámban.
,, aspidota, *M. Tr.* Pámban.
Ophiomaza cacaotica, *Lym.* Pámban.
Astrophyton clavatum, *Lym.* Tuticorin pearl banks.

ECHINOIDEA.

Phyllacanthus baculosa, *A. Ag.* Tuticorin.
Echinometra lucunter, *Leske.* Tuticorin.
Stomopneustes variolaris, *Lmk.* Pámban.
Pseudoboletia maculata, Tuticorin.
Temnopleurus toreumaticus, *Leske.* Pámban.
Salmacis bicolor, *Ag.* Tuticorin pearl banks.
,, dussumieri, *Ag.* Pámban. Common in fishing nets at Madras.
,, sulcata, *Ag.* Tuticorin.
Echinus angulosus, *Ag.* Pámban. (Spines quite white).
Toxophneustes pileolus, *Ag.* Tuticorin.
Fibularia volva, *Ag.* Pámban.
Clypeaster humilis, *Ag.* Tuticorin pearl banks.
Laganum decagonale, *Less.* Pámban.
,, depressum, *Less.* Pámban.
Echinodiscus biforis, *Ag.* Tuticorin.
,, auritus, *Leske.* Pámban.
Echinolampas oviformis, *Gray.* Pámban.
Lovenia elongata, *Gray.* Pámban.
Rhinobrissus pyramidalis, *Ag.* Pámban.
Brissus unicolor, *Leske.* Pámban.
Metalia sternalis, *Lmk.* Tuticorin.

HOLOTHUROIDEA.

Cucumaria semperi, *Bell.* Pámban.
Colochirus quadrangularis, *Less.* Tuticorin pearl banks.
Actinocucumis difficilis, *Bell.* Pámban.
Haplodactyla australis, *Semper.* Tuticorin.
Holothuria atra, *Jäger,* Pámban.
,, marmorata, *Jäger.* Pámban (edible trepang).
,, monacaria, *Less.* Pámban.
,, vagabunda. *Selenka.* Tuticorin.

Synapta recta, *Semper* ? Pámban.
Thyone sacellus, *Silenka.* A specimen in the Madras museuem shows the tentacles. teeth, etc., which were ejected during life.

GEPHYREA.

I. Gephyrea chætifera.

Thalassema formulosum.

II. Gephyrea achæta.

Phascolosoma pellucidum, *Keferstein.*
Dendrostoma signifer, *Selenka* and *de Man.*
Sipunculus robustus, *Keferstein.*

Of these four species, dredged off Rámésvaram island, only *Dendrostoma signifer* was abundant.

CRUSTACEA.

As regards the decapod and stomatopod crustacea Mr. J. R. Henderson writes to me:—"This collection is one of the most important which has ever been formed on the Indian coast. It contains about a hundred and sixty species, not more than ten or twelve of which are new to science; but a number of rare or little-known forms are present, and the geographical distribution of most of these has been greatly extended by their discovery on the South Indian shores. Upwards of three hundred species of decapod and stomatopod Crustacea have been recorded from the Bay of Bengal, which may be conveniently held to include the coasts from Ceylon on the one side to Singapore on the other, along with the numerous groups of islands situated within this area. Yet, with the exception of a small collection from Madras report on by Prof. Heller in the Crustacea of the *Reise der Novara*, our knowledge of the species which inhabit the Indian coast proper is limited to a few scattered papers, and to those forms recorded by the older writers under the somewhat vague localisation 'Indian Seas.'

"The crustacean fauna of the Gulf of Manaar shows, as might be expected, a considerable proportion of coral reef species—widely distributed forms, which occur in suitable localities throughout the vast Indo-Pacific region."

An account of the decapod and stomatopod crustacea collected by myself off both the Madras and Ceylon coasts

of the gulf of Manaar has been included by Mr. Henderson in his recent 'Contribution to Indian Carcinology,'[30] to which I am indebted for the following list of species, which includes several species (indicated by an asterisk) recorded as new.

Pámban and Tuticorin are on the western or Madras side of the gulf, and Silavaturai and the Cheval and Muttuwartu pars (pearl banks) on the eastern or Ceylon side of the gulf.

DECAPODA.

Brachyura.

Oncinopus aranea, *De Haan.* Muttuwartu.
Huenia Proteus, *De Haan.* Pámban, Tuticorin.
Simocarcinus simplex (*Dana.*) Tuticorin.
Menœthius monoceros (*Latr.*) Pámban, Tuticorin, Muttuwartu, Silavaturai.
Doclea hybrida (*Fabr*) Pámban.
Stenocionops cervicornis, (*Herbst.*) Tuticorin.
Hyastenus Pleione (*Herbst.*) Silavaturai.
,, Hilgendorfi, *De Man.* Pámban, Tuticorin, Cheval.
Chlorinoides Coppingeri, *Haswell.* Muttuwartu.
Naxia hirta (*A. Milne Edw.*) Tuticorin.
Schizophrys aspera (*Milne Edw.*) Pámban, Tuticorin.
Micippa Philyra (*Herbst.*) Pámban, Tuticorin.
,, Thalia (*Herbst.*) Pámban, Tuticorin, Muttuwartu.
Tylocarcinus styx (*Herbst.*) Pámban, Tuticorin, Muttuwartu.
Lambrus contrarius (*Herbst.*) Tuticorin.
,, affinis, *A. Milne Edw.* Pámban, Tuticorin.
,, longispinus, *Miers.* Tuticorin.
,, Holdsworthi, *Miers.* Tuticorin.
,, hoplonotus, *Ad & White.* Muttuwartu.
Zebrida Adamsii, *White.* Tuticorin.
Paratymolus sexspinosus, *Miers.* Tuticorin.
Atergatis integerrimus (*Lmk.*). Pámban, Tuticorin.
,, floridus (*Rumph.*) Pámban, Tuticorin.
,, lœvigatus, *A. Milne Edw.* Tuticorin.
Carpilodes tristis, *Dana.* Muttuwartu.
,, margaritatus, *A. Milne Edw.* Pámban, Tuticorin.
Liomera punctata (*Milne Edw.*). Tuticorin, Muttuwartu.
Lophactæa granulosa (*Rüpp.*) Pámban, Tuticorin.
,, semigranulosa (*Heller.*) Pámban, Muttuwartu.
* ,, fissa, *Henderson.* Tuticorin.
Actæa granulata (*Aud.*) Pámban, Tuticorin, Cheval.

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[30] *Trans. Linn. Soc. Zoology,* vol. v, part 10, 1893.

Actæa calculosa (*Milne Edw.*) Tuticorin, Muttuwartu.
,, nodulosa (*White*). Tuticorin.
* ,, Peronii (*Milne Edw.*) var. squamosa. Muttuwartu.
,, rufopunctata (*Milne Edw.*) Tuticorin, Cheval.
,, Ruppellii (*Krauss.*) Pámban, Tuticorin.
*Hypocœlus rugosus, *Henderson.* Tuticorin.
Euxanthus melissa (*Herbst.*) Tuticorin.
Polycremnus ochtodes, *Herbst.* Muttuwartu.
*Halimede Thurstoni, *Henderson.* Tuticorin.
Cycloxanthus lineatus, *A. Milne Edw.* Tuticorin.
Lophozozymus Dodone (*Herbst.*) Pámban, Tuticorin, Muttuwartu.
,, cristatus, *A. Milne Edw.* Muttuwartu.
Chlorodius niger (*Försk.*) Pámban, Tuticorin, Muttuwartu.
Chlorodopsis spinipes (*Heller.*) Muttuwartu.
Leptodius exaratus, (*Milne Edw.*) Pámban, Tuticorin, Silavaturai.
Etisus lœvimanus, *Randall.* Pámban, Tuticorin.
Phymodius monticulosus (*Dana.*) Tuticorin.
Cymo Andreossyi (*Aud.*) Pámban, Tuticorin.
Menippe Rumphii (*Fabr.*) Pámban, Tuticorin.
Actumnus setifer (*De Haan.*) Muttuwartu.
* ,, verrucosus, *Henderson.* Tuticorin, Muttuwartu.
Pilumnus vespertilio (*Fabr.*) Pámban, Tuticorin.
,, labyrinthicus *Miers.* Pámban.
Trapezia Cymodoce (*Herbst.*) Pámban, Tuticorin, Muttuwartu.
,, rufopunctata (*Herbst.*) Tuticorin.
Tetralia glaberrima (*Herbst.*) Pámban, Tuticorin, Muttuwartu.
Eriphia lœvimana *Latr.* Pámban, Tuticorin.
Neptunus pelagicus (*Linn.*) Tuticorin.
,, gladiator (*Fabr.*) Pámban.
,, sanguinolentus (*Herbst.*) Pámban.
,, armatus, *A. Milne Edw.* Pámban.
,, Sieboldi, *A. Milne Edw.* Muttuwartu.
Thalamita prymna (*Herbst.*) Pámban, Tuticorin.
,, admete, (*Herbst.*) Pámban.
,, Savignyi *A. Milne Edw.* Pámban, Tuticorin.
,, sima, *Milne Edw.* Tuticorin.
,, integra, *Dana.* Pámban, Tuticorin.
,, sexlobata, *Miers.* Tuticorin.
Goniosoma cruciferum (*Fabr.*) Tuticorin.
,, natator (*Herbst.*) Pámban.
,, annulatum (*Fabr.*) Pámban, Tuticorin.
,, Hellerii, *A. Milne Edw.* Pámban, Tuticorin.
,, orientale (*Dana.*) Tuticorin.
Lissocarcinus lœvis, *Miers.* Tuticorin.
Kraussia nitida, *Stm.* Tuticorin.
Cardisoma carnifex, (*Herbst.*) Tuticorin.
Ocypoda ceratophthalma (*Pallas.*) Pámban, Tuticorin.

Ocypoda macrocera, *Milne Edw.* Pámban, Tuticorin.
,, platytarsis, *Milne Edw.* Pámban.
,, cordimana, *Latr.* Tuticorin.
Gelasimus annulipes, *Latr.* Pámban, Tuticorin.
Macrophthalmus depressus, (*Rüpp.*) Pámban.
Scopimera myctiroides (*Milne Edw.*) Tuticorin.
Metograpsus messor (*Forsk.*) Pámban, Tuticorin.
Gràpsus strigosus (*Herbst.*) Pámban, Tuticorin.
,, maculatus (*Catesby.*) Tuticorin.
Leiolophus planissimus (*Herbst.*) Pámban.
Sesarma quadrata (*Fabr.*) Tuticorin.
Xenophthalmus pinnotheroides, *White.* Pámban.
Elamene truncata, *A. Milne Edw.* Silavaturai.
Calappa hepatica (*Linn.*) Pámban, Tuticorin.
,, gallus (*Herbst.*) Pámban, Tuticorin.
Matuta victrix, *Fabr.* Tuticorin.
,, Miersii, *Henderson.* Tuticorin.
Leucosia craniolaris (*Linn.*) Pámban, Muttuwartu.
Pseudophilyra Melita, *De Man.* Muttuwartu.
Philyra scabriuscula (*Fabr.*) Pámban, Tuticorin.
,, Adamsii, *Bell.* Pámban, Silavaturai.
,, platycheira, *De Haan.* Silavaturai.
,, globosa (*Fabr.*) Pámban, Tuticorin.
Myra fugax (*Fabr.*) Pámban.
Ebalia Pfefferi, *De Man.* Muttuwartu.
* ,, fallax, *Henderson,* Muttuwartu.
Nursia plicata (*Herbst.*) Pámban.
,, abbreviata, *Bell.* Pámban, Silavaturai.
Dorippe dorsipes (*Linn.*) Pámban, Silavaturai.
,, facchino (*Herbst.*) Pámban, Tuticorin.

Anomura.

Dromidia unidentata (*Rüpp.*) Tuticorin.
,, australiensis, *Haswell.* Silavaturai.
Cryptodromia pentagonalis, *Hilg.* Silavaturai, Muttuwartu.
Pseudodromia integrifrons, *Henderson.* Tuticorin.
* Raninoides serratifrons, *Henderson.* Cheval.
Hippa asiatica, *Milne Edw.* Pámban.
Albunea symnista (*Linn.*) Pámban.
* ,, Thurstoni, *Henderson.* Cheval.
Cœnobita rugosa, *Milne Edw.* Pámban, Tuticorin, Silavaturai.
Diogenes Diogenes (*Herbst.*) Pámban, Tuticorin.
,, merguiensis, *De Man.* Muttuwartu.
,, miles (*Herbst.*) Pámban, Silavaturai.
,, custos (*Fabr.*) Pámban.
* ,, planimanus, *Henderson.* Pámban.
,, avarus, *Heller.* Pámban, Tuticorin.
* ,, costatus, *Henderson.* Pámban, Tuticorin.

Pagurus punctulatus (*Oliv.*) Pámban, Tuticorin.
,, deformis, *Milne Edw.* Pámban, Tuticorin.
,, varipes, *Heller.* Tuticorin, Muttuwartu.
,, setifer, *Milne Edw.* Tuticorin.
* Troglopagurus manaarensis, *Henderson.* Tuticorin, Muttuwartu.
Aniculus aniculus (*Fabr.*) Tuticorin, Muttuwartu.
,, strigatus (*Herbst.*) Tuticorin.
Clibanarius padavensis, *De Man.* Pámban, Tuticorin.
,, arethusa, *De Man.* Pámban, Muttuwartu.
* Eupagurus zebra, *Henderson.* Muttuwartu
Petrolisthes dentatus (*Milne Edw.*) Pámban, Tuticorin, Muttuwartu.
,, Boscii (*Aud.*) Pámban, Muttuwartu.
,, militaris (*Heller*) Pámban, Cheval, Muttuwartu.
Porcellanella triloba, *White.* Pámban.
Polyonyx obesulus, *Miers.* Pámban, Tuticorin.
,, tuberculosus. *De Man,* Pámban, Cheval.
Galathea elegans, *White.* Tuticorin.
,, spinosirostris, *Dana.* Muttuwartu.
Munida spinulifera, *Miers.* Muttuwartu.

Macrura.

Gebiopsis Darwinii, *Miers.* Pámban, Tuticorin, Cheval.
Thenus orientalis (*Fabr.*) Muttuwartu.
Panulirus dasypus (*Latr.*) Silavaturai.
Alpheus Edwardsii (*Aud*) Pámban, Tuticorin, Muttuwartu.
,, hippothoë, *De Man.* Pámban.
,, frontalis, *Say.* Tuticorin.
,, lœvis, *Randall.* Pámban, Tuticorin.
,, Neptunus, *Dana,* Pámban.
Rhynchocinetes rugulosus, *Stm.* Tuticorin
Pontonia tridacnæ, *Dana.* Pámban, Tuticorin.

STOMATOPODA.

Lysiosquilla maculata, (*Fabr.*) Tuticorin.
Squilla nepa, *Latr.* Tuticorin.
,, affinis, *Berthold.* Tuticorin.
,, scorpio, *Latr.* Tuticorin.
,, raphidea, *Fabr.* Pámban.
Pseudosquilla ciliata (*Fabr.*) Pámban.
Gonodactylus glaber, *Brooks.* Pámban, Tuticorin, Silavaturai.
,, Demanii, *Henderson.* Pámban.

CAPRELLIDÆ.

Several specimens of *Paradeutella bidentata,* Mayer, were found adhering to the stems of *Juncella juncea* on the

Pámban reef. A male was sent to the Naples zoological station for identification by Dr. Paul Mayer, who reported it as being 1 m.m. longer than the longest specimen in his possession.

The type specimens, described by Dr. Mayer,[30] were collected by the Swedish Naturalist, K. Fristedt at Pámban, together with *Metaprotella haswelliana*, Mayer; *Metaprotella excentrica*, Mayer; and *Metaprotella problematica*, Mayer, in 1—4 fathoms on bryozoa and sponges.

MOLLUSCA.

The following list of mollusca, which I have collected off both the Indian and Ceylon coast of the gulf of Manaar, includes (1) those which were collected on the beach, all shells which were worn and bore evidence of having been rolled in from a distance being rejected, and only those which appeared to be fresh being retained; (2) those which were obtained by dredging, and straining the contents of the dredge through sieves; (3) those which were cellected on the coral reefs on clear days or at low tide; (4) those which were brought up from the pearl banks and other localities by native divers; (5) those which were obtained by examining the sweepings from the kottus (oyster-sheds) during the pearl fishery; (6) those which were found attached to algæ and gorgoniæ, or obtained by breaking up coral blocks with a crowbar, and extracting the shells which were buried in cavities bored by the animals during life.

Pámban, Kilakarai, and Tuticorin are on the western or Madras side of the gulf of Manaar; Dutch bay, Silavaturai, and the Muttuwartu, Cheval and Karaitivu pars (pearl-banks) are on the eastern or Ceylon side of the gulf.

CEPHALOPODA.

Spirula Peronii, *Lmk.* Pámban, Kilakarai, Dutch Bay, Karaitivu.

Nautilus pompilius, *Linn.* Pámban.

PTEROPODA.

Styliola acicula. Pelagic over coral reefs.

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[30] *Faun und Flor.* Golf. v. Neapel. Mon. XVII, pp. 29, 30.

HETEROPODA.

Ianthina affinis, *Rv.* Muttuwartu.
,, africana, *Rv.* Very abundant, coincidently with *Physalia*, one evening at Kilakarai.

GASTROPODA.

Murex anguliferus, *Lmk.* Tuticorin.
,, ,, var. ponderosus. Muttuwartu.
,, badius (?), *Rv.* Pámban, Tuticorin.
,, haustellum, *Linn.* Pámban, Tuticorin.
,, palmiferus, *Sow.* Karaitivu.
,, tenuispina, *Lmk.* Pámban.
,, ternispina, *Lmk.* Pámban.
Fusus colus, *Linn.* Pámban.
,, tuberculatus, *Lmk.* Pámban.
Melongena vespertilio, *Lmk.* Pámban.
Pollia rubiginosa, *Rv.* Pámban.
Tritonidea melanostoma, Tuticorin, Cheval.
,, undosa, *Linn.* Pámban.
Pleurotoma tigrina, *Lmk.* Pámban.
,, (Drillia) crenularis, *Lmk.* Pámban.
,, (,,) inconstans, *Smith.* Pámban.
,, (Surcula) javana, *de Boiss.* Pámban.
Daphnella varicifera, *Pease.* Muttuwartu.
Cythara pallida, *Rv.* Pámban, Tuticorin.
Clathurella lemniscata, *Nevill.* Pámban.
,, rubroguttata, *H. Ad.* Pámban, Tuticorin.
Mangelia Fairbanki, *Nevill.* Dutch Bay.
Triton chlorostomus, *Lmk.* Pámban.
,, cingulatus, *Pf.* Tuticorin,
,, retusus, *Lmk.* Tuticorin.
,, (Persona) cancellinus, *de Boiss.* Tuticorin.
Tritonium cingulatum, *Lmk.* Pámban, Cheval.
,, lampas, *Linn.* Pámban.
,, pileare, *Linn.* Pámban.
Ranella foliata, *Brod.* Tuticorin.
,, granifera, *Lmk.* Pámban, Cheval.
,, pusilla, *Brod.* Muttuwartu.
,, tuberculata, *Brod.* Pámban.
Hindsia acuminata, *Rv.* Tuticorin.
Bullia melanoides, *Desh.* Pámban.
Nassa canaliculata, *Lmk.* Pámban.
,, coronula, *A. Ad.* Karaitivu.
,, cribraria, *Marrat.* Tuticorin.
,, delicata, *Rv.* Muttuwartu.
,, fasciata, *Quoy & Gaim.* Tuticorin.
,, marginulata, *Lmk.* Pámban, Tuticorin, Dutch Bay.

Nassa marginulata var. minor. Pámban.
,, ,, var. conoidalis. Pámban, Kilakarai, Karaitivu.
,, ornata, *Kien.* Pámban.
,, suturalis, *Lmk.* Pámban.
,, thersites, *Brug.* Pámban, Tuticorin, Karaitivu.
,, (Niotha) albescens, *Dunk.* Pámban.
,, (,,) australis, *A. Ad.* Pámban.
Eburna spirata, *Lmk.* Pámban
,, zeylanica, *Lmk.* Pámban.
Purpura carinifera, *Lmk.* Pámban.
,, Rudolphi, *Lmk.* Pámban.
Ricinula undata, *Chemn.* Pámban, Kilakarai.
Olivancillaria nebulosa, *Lmk.* Pámban, Tuticorin.
Oliva candida, *Lmk.* Pámban.
,, gibbosa, *Born.* Pámban.
,, ispidula, *Linn.* Pámban.
Ancillaria fulva, *Swains.* Muttuwartu.
,, oryza, *Rv.* Tuticorin, Kilakarai.
,, (Sparella) acuminata, *Sow.* Pámban.
,, (,,) ampla, *Gm.* Pámban, Tuticorin, Cheval.
,, (,,) cinnamonea, *Lmk.* Tuticorin.
Fasciolaria filamentosa, *Chemn.* Pámban.
,, trapezium, *Linn.* Pámban.
Tudicla spirillus, *Lmk.* Pámban.
Latirus microstomus, *Kob.* Muttuwartu.
,, pulchellus, *Rv.* Karaitivu.
,, turritus, *Gm.* Karaitivu.
Turbinella cornigera, *Lmk.* Tuticorin.
,, pyrum, *Lmk.* Pámban, Tuticorin.
,, rapa, *Lmk.* Tuticorin.
Voluta interpuncta, *Martyn.* Tuticorin.
Cymbium indicum, *Gm.* Pámban.
Mitra dublicata, *Rv.* Pámban.
,, rubricata, *Rv.* Pámban.
,, zebuensis, *Rv.* Muttuwartu.
Strigatella litterata, *Lmk.* Pámban.
Marginella angustata, *Sow.* Pámban, Tuticorin, Cheval, Karaitivu.
,, dens, *Rv.* Tuticorin, Dutch Bay, Muttuwartu.
,, navicella, *Rv.* Muttuwartu.
Erato angistoma, *Rv.* Tuticorin.
Zafra atrata, *Gould.* Pámban.
Columbella flavida, *Lmk.* Tuticorin, Taraitivu.
,, mindorensis, *Rv.* Pámban, Kilakarai, Tuticorin, Karaitivu.
,, pusilla, *Dunk.* Pámban.
,, undata, Pamban.

Columbella versicolor, *Sow.* Pámban, Kilakarai, Tuticorin, Karaitivu, Muttuwartu.
,, (Anachis) terpsichore, *Sow.* Pámban, Tuticorin, Karaitivu.
Engina trifasciata, *Rv.* Pámban.
,, zonata, *Rv.* Pámban.
Harpa ventricosa, *Lmk.* Pámban.
Cassis areola, *Lmk.* Pámban.
,, canaliculata, *Lmk.* Pámban.
,, (Bezoardica) glauca, *Brug.* Pámban.
Dolium fasciatum, *Lmk.* Pámban.
,, maculatum, *Lmk.* Pámban.
,, olearium, *Linn.* Pámban.
Ficula lævigata, *Rv.* Pámban.
,, reticulata, *Lmk.* Pámban.
Pyrula cochlidium, *Linn.* Pámban, Cheval.
Natica ala papilionis, *Chemn.* Tuticorin.
,, columnaris, *Recl.* Muttuwartu.
,, lineata, *Lmk.* Pámban.
,, maculosa, *Lmk.* Pámban, Dutch Bay.
,, maroccana, *Chemn.* Pámban, Tuticorin.
,, pavimentum, *Rv.* Cheval.
,, pulicaris, *Phil.* Pámban, Tuticorin.
,, (Mamilla) melanostoma, *Lmk.* Tuticorin.
,, (Neverita) didyma, *Bolt.* Pámban, Muttuwartu.
,, (Ruma) melanostoma, *Lmk.* Cheval, Muttuwartu.
Sigaretus neritoideus, *Linn.* Pámban.
Naticina papilla, *Chemn.* Pámban.
Scalaria aculeata, *Sow.* Pámban.
,, decussata, *Pease.* Pámban.
Terebra duplicata, *Linn.* (var Reeve). Cheval.
,, myuros, *Lmk.* Pámban.
Ringicula dolearis (?) *Gould.* Tuticorin.
,, propinquans, *Hinds.* Pámban.
Alaba rectangularis, *Cramer.* Pámban.
Solarium lævigatum, *Lmk.* Pámban.
,, perspectivum, *Lmk.* Pámban.
,, (Torinia) cælata, *Hinds.* Pámban, Muttuwartu
,, (Torinia) fulvum, *Hinds.* Pámban.
Conus amadis, *Chemn.* Pámban.
,, dispar, *Sow.* Pámban.
,, figulinus, *Linn* Pámban.
,, geographus, *Linn.* Tuticorin.
,, glans, *Hwass.* Pámban.
,, hebræus, *Linn.* Pámban.
,, litteratus, *Linn.* Tuticorin.
,, longurionis, *Kien.* Tuticorin.
,, marmoreus, *Linn.* Pámban.
,, peplum, *Chemn.* Muttuwartu.

Conus piperatus, *Dillwyn.* Pámban.
,, striatus, *Linn.* Tuticorin.
,, textile, *Linn.* Tuticorin.
Strombus canarium, *Linn.* Pámban, Tuticorin.
,, marginatus, *Linn.* Pámban.
,, urceus, *Linn.* (var. plicatus). *Lmk.* Pámban.
Pterocera aurantia, *Lmk.* Pámban.
,, lambis, *Linn.* Pámban.
,, scorpius, *Linn.* Pámban, Tuticorin.
Cypræa arabica, *Linn.* Pámban, Tuticorin.
,, ,, ,, var. Smith. Tuticorin.
,, caput serpentis, *Linn.* Tuticorin.
,, carneola, *Linn.* Tuticorin.
,, caurica, *Linn.* Pámban.
,, errones, *Linn.* Pámban.
,, hirundo, *Gm.* Pámban.
,, lentiginosa, *Gray.* Pámban.
,, lynx, *Linn.* Pámban.
,, mauritiana, *Linn.* Pámban, Tuticorin.
,, moneta, *Linn.* Pámban.
,, ocellata *Linn.* Pámban, Tuticorin.
,, onyx, *Linn.* Pámban.
,, talpa, *Linn.* Tuticorin.
,, tigris, *Linn.* Pámban, Tuticorin.
,, vitellus, *Linn.* Tuticorin.
,, (Trivia) oryza, *Lmk.* Karaitivu.
,, (,,) producta, *Gask.* Tuticorin.
Ovulum (Radius) arcuatum, *Rv.* Cheval.
,, (,,) birostre, *Linn.* Pámban.
,, (,,) formicarium, *Sow.* Tuticorin.
,, (,,) formosus, *Ad.* & *Rv.* Pámban.
,, (,,) volva, *Linn.* Pámban.
Cancellaria costifera, *Sow.* Pámban, Tuticorin.
,, elegans, *Sow.* Pámban.
,, serrata, *Rv.* Dutch Bay.
Cerithium breviculum, *Sow.* Pámban.
,, corallinum, *Defr.* Tuticorin.
,, morus, *Lmk.* Pámban.
,, purpurascens, *Sow.* Tuticorin.
,, rugosum, *Wood.* Tuticorin.
,, splendens, *Sow.* Pámban.
,, (Aluco) obeliscus, *Brug* Pámban, Karaitivu.
,, (Bittium) lineatumn, *Dunk.* Muttuwartu.
,, (Tympanotomus) alatum, Pámban.
,, (,,) fluviatile, *Potiez.* Pámban.
Colina pupæformis, *A Ad.* Pámban, Kilakarai, Tuticorin.
Triforis cingulatus, *Dunk.* Tuticorin, Dutch Bay.
,, concinna, *Hinds.* Pámban, Tuticorin.
,, violacea, *Quoy* & *Gaim.* Muttuwartu.

Potamides cingulatus, *Gm.* Tuticorin.
,, (Pyrazus) palustris, *Linn.* Pámban.
Melania collistricta, *Rv.* Tuticorin.
,, tuberculata, *Mull.* Tuticorin.
Littorina glabrata, *Phil.* Pámban.
,, intermedia, *Phil.* Pámban.
,, scabra, *Linn,* Pámban, Tuticorin.
,, undulata, *Gray.* Pámban.
Planaxis pyramidalis, *Gm.* Pámban, Tuticorin.
,, suturalis, *Smith.* Muttuwartu.
Rissoina antoni, *Schum.* Pámban.
,, media, *Schum.* Pámban, Tuticorin.
,, planaxoides, Pámban.
,, pusilla, *Rv.* Muttuwartu.
,, (Phosinella) clathrata, *A. Ad.* Pámban, Tuticorin.
Turritella attenuata, *Rv.* Pámban.
,, duplicata, *Linn.* Pámban.
Siliquaria encaustica, *Mörch.* Pámban, Tuticorin.
,, lactea, *Lmk.* Pámban.
Calyptræa neptuni, *Schum.* Pámban.
Trochita (Galerus) extinctorium, *Sow.* Pámban, Tuticorin.
Crepidula (Siphopatella) walchi, *Herm.* Pambán, Tuticorin, Dutch Bay.
Capulus, sp. Pámban.
Hipponyx acutus, *Quoy & Gaim.* Tuticorin.
Vanicora granulosa, *Recl.* Pámban.
,, Quoyiana, *A. Ad.* Pámban.
Nerita albicilla, *Linn.* Pámban.
,, chamæleon, *Linn.* Pámban.
,, maura, *Brod.* Pámban.
,, plicata, *Linn.* Pámban.
,, Rumphii, *Recl.* Pámban.
,, sqamulata, *Le Guill.* Pámban.
Neritina (Clithon) ualanensis, *Less.* Pámban.
,, (Smaragdia) rangiana, *Recl.* Pámban, Tuticorin, Dutch Bay.
Phasianella nivosa, *Rv.* Kilakarai, Tuticorin.
Turbo petholatus, *Linn.* Pámban.
,, (Senectus) margaritaceus, *Linn.* Pámban, Tuticorin.
Calcar columellare, *Phil.* Pámban, Tuticorin, Cheval.
Liotia cidaris, *Rv.* Pámban.
Rotella costata, *Val.* Pámban.
,, vestiaria, *Sow.* Tuticorin.
Delphinula atrata, *Chemn.* Pámban.
,, distorta, *Lmk.* Pámban, Tuticorin.
Trochus niloticus, *Linn.* Pámban.
,, (Clanculus) clanguloides, *Wood.* Pámban, Tuticorin.
,, (Euchelus) atratus, *Gm.* Pámban.
,, (,,) circulatus, *Anton.* Pámban, Dutch Bay.

Trochus (Euchelus) tricarinatus, *Lmk.* Pámban.
,, (Gibbula) variabilis, *Ad.* Tuticorin.
,, (Monilea) Solandri, *Phil.* Pámban.
,, (Polydonta) costatus, *Gm.* Pámban.
,, (,,) radiatus, *Gm.* Pámban.
,, (Zizyphinus) polychroma, *Rv.* Pámban, Kilakarai, Tuticorin, Muttuwartu.
,, (,,) tranquebaricus, *Chemn.* Pámban.
Gena stellata, *Sow.* Muttuwartu.
Haliotis parva, *Linn.* Muttuwartu.
,, semistriata, *Rv.* Pámban.
,, varia, *Linn.* Pámban.
Fissurella clathrata, *Rv.* Pámban.
,, octogona, *Rv.* Pámban, Tuticorin.
,, singaporensis, *Rv.* Tuticorin.
,, ticaonica, *Rv.* Muttuwartu.
Emarginula obovata, *A. Ad.* Pámban, Tuticorin.
Scutum unguis, *Linn.* Pámban, Tuticorin.
Dentalium variabile, *Desh.* Pámban, Tuticorin.
Scutellina asperulata, *A. Ad.* Pámban.
,, galatea, *Lmk.* Pámban.
Chiton. Several undetermined species.
Solidula solidula, *Lmk.* Pámban.
Hydatina circulata, *Martyn.* Pámban.
Cylichna voluta, *Quoy. & Gaim.* Kilakarai.
Bulla ampulla, *Linn.* Pámban.
Haminea cymbalum, *Quoy & Gaim.* Pámban.
Atys porcellana, *Gould.* Pámban.
,, tortuosus, *A. Ad.* Kilakarai.
Philine aperta, *Linn.* Pámban.
Oxynoe delicatula, *Nevill.* (= O. Sieboldii, *Krohn* ?). Pámban.
Volvatella cincta, *Nevill.* (=V. fragilis, *Pease* ?) Pámban.
Lobiger viridis, *G. & H. Nevill.* Tuticorin.
Aplysia leporina, Pámban.
Dolabella Rumphi, *Cuv.* ? Pámban.
Siphonaria exigua, *Sow.* Muttuwartu.

LAMELLIBRANCHIATA.

Pholas (Martesia) striata, *Linn.* Pámban.
Dactylus orientalis, *Gm.* Pámban.
Jouannetia globosa, *Quoy.* Pámban, Kilakarai.
Guetra nucifera, *Speng.* Pámban.
Rocellaria ovata, *Sow.* Pámban.
Aspergillum dichotomum, *Rv.* Pámban.
Solen adspersus, *Dunk.* Pámban, Tuticorin, Dutch Bay.
,, corneus, *Lmk.* Tuticorin.
Cultellus radiatus, *Linn.* Pámban, Tuticorin.

Corbula crassa, *Hinds*. Karaitivu.
,, fortisulcata, *Smith*. Tuticorin.
,, modesta, *Hinds*. Pámban, Tuticorin, Muttuwartu.
,, sulculosa, *H. Ad*. Pámban, Tuticorin.
Anatina labiata, *Rv*. Pámban.
Theora fragilis, *H. Ad*. Pámban, Tuticorin.
Mactra attenuata. Karaitivu.
,, corbiculoides, *Desh*. Pámban, Tuticorin.
,, decora, *Desh*. Tuticorin, Dutch Bay.
,, lurida, *Phil*. Dutch Bay.
Lutraria (Merope) nicobarica, *Gm* Tuticorin.
Soletellina diphos, *Linn*. Pámban.
,, donacioides, *Rv*. Dutch Bay.
Tellina assimilis, *Rv*. Dutch Bay.
,, chinensis, *Hanl*. Tuticorin, Karaitivu.
,, perplexa, *Hanl*. Pámban.
,, scalpellum, *Hanl*. Pámban.
,, sulcata, *Wood*. Pámban.
,, (Arcopagia) pristis, *Lmk*. Pámban.
,, (Macalia) Bruguierei, *Hanl*. Pámban.
,, (Metis) angulata, *Chemn*. Pámban.
,, (,,) ephippium, *Spengl*. Pámban.
Dosinia histrio, *Gm*. Pámban.
,, modesta, *Rv*. Pámban.
,, puella, *E. Rom*. Pámban, Dutch Bay.
,, ,, From black mud. Kilakarai, Dutch Bay.
,, trigona, *Rv*. Pámban, Dutch Bay, Karaitivu.
Donax æneus, *March*. Pámban, Tuticorin.
,, cuneatus, *Linn*. Pámban, Silavaturai.
,, Dysoni, *Desh*. Pámban, Tuticorin.
,, faba, *Chemn*. Pámban, Tuticorin.
,, paxillus, *Rv*. Pámban, Tuticorin.
,, scortum, *Linn*. Pámban.
Semele casta, *A. Ad*. Pámban.
,, crenulata, *Sow*. Pámban.
,, exarata, *Ad. & Rv*. Pámban.
,, striata, *Rüpp*. Pámban, Tuticorin, Cheval, Muttuwartu.
Mesodesma (Paphia) trigona, *Desh*. Tuticorin.
,, (,,) glabratum, *Lmk*. Pámban, Tuticorin.
Cytharea morphina, *Lmk*. Pámban,
Callista erycina, *Linn*. Pámban, Kilakarai.
,, (Meretrix) casta, *Hanl*. Pámban.
Circe alabastrum, *Rv*. Pámban.
,, dispar, *Chemn*. var. abbreviata, *Lmk*. Pámban.
,, ,, *Chemn*. var. transversalis, *Desh*. Pámban.
,, pectinata, *Linn*. Pámban. Cythoria.
,, personata, *Desh*. Pámban, Muttuwartu.
,, scripta, *Linn*. Pámban, Karaitivu.
,, (Crista) divaricata, *Chemn*. Pámban, Tuticorin.

Circe (Crista) gibba, *Lmk.* Pámban, Tuticorin.
Venus arakana, *Nevill.* Pámban, Kilakarai, Karaitivu Dutch Bay.
,, foliacea, *Phil.* Pámban, Cheval, Dutch Bay.
,, Lamarcki, *Gray.* Pámban, Tuticorin.
,, lamellaris, *Schum.* Pámban.
,, plicata, *Linn.* Pámban.
,, reticulata, *Linn.* Pámban.
,, toreuma, *A. Gould.* Cheval.
,, (Anaitis), calophylla, *Phil.* Pámban, Karaitivu.
,, (Chione) Layardi, *Sow.* Pámban.
,, (Cryptogramma) squamosa, *Linn.* Karaitivu.
,, (Sunetta) effossa, *Hanl.* Pámban, Tuticorin, Cheval.
,, (,,) excavata, *Hanl.* Cheval.
,, (,,) scripta, *Linn.* Pámban, Tuticorin.
,, (,,) truncata, *Desh.* Pámban.
,, (Timoclea) imbricata, *Sow.* Tuticorin, Karaitivu.
,, (,,) scabra, *Hanl.* Pámban, Dutch Bay.
Tapes adspersa, *Chemn.* Pámban, Muttuwartu.
,, litterata, *Linn.* Pámban.
,, malabaricus, *Chemn.* Pámban, Tuticorin.
,, rotundata, *Linn.* Pámban.
,, textrix, *Chemn.* Pámban, Dutch Bay, Karaitivu.
,, undulata, *Born.* Tuticorin.
Hemitapes ceylonensis, *Sow.* Pámban.
,, pingues, *Chemn.* Pámban, Dutch Bay.
Venerupis carditoides, *Lmk.* Tuticorin, Dutch Bay.
,, ,, var. Muttuwartu.
Petricola (Narania) divaricata, *Chemn.* Pámban.
Cardium asiaticum, *Brug.* Tuticorin.
,, latum, *Born.* Tuticorin.
,, leucostoma, *Born.* Pámban.
,, retusum, *Linn.* Pámban, Tuticorin.
,, rubicundum, *Rv.* Pámban, Dutch Bay.
,, rugosum, *Lmk.* Tuticorin.
,, (Papyridea) rugatum, *Gron.* Pámban, Tuticorin.
Lævicardium australe, *Sow.* Tuticorin.
,, retusum, *Linn.* Pámban.
Lunulicardia subretusa, *Sow.* Pámban.
Isocardia Lamarcki, *Rv.* Muttuwartu.
,, Moltkeana, *Chemn.* Muttuwartu.
Chama lazarus, *Linn.* Pámban.
Lucina pisum, *Rv.* Pámban, Tuticorin, Karaitivu.
,, (Anodontia) edentula, *Linn.* Pámban.
,, (Divaricella) Cumingii, *Ad. & Ang.* Tuticorin.
,, (Lentillaria) divergens, *Phil.* Tuticorin, Muttuwartu.
Codakia Fischeriana, *Issel.* Pámban.
Cryptodon vesicula, *Gould.* Tuticorin.

Galeomma mauritiana, *Desh.* Pámban.
Scintilla ambigua, *Desh.* Pámban.
,, candida, *Desh.* Pámban.
,, Hanleyi, *Sow.* Pámban.
Crassatella radiata, *Sow.* Pámban, Tuticorin, Cheval, Dutch Bay.
,, rostrata, *Lmk.* Pámban.
Cardita bicolor, *Lmk.* Pámban, Kilakarai, Tuticorin.
,, variegata, *Brug.* Pámban, Tuticorin.
,, ,, var. Muttuwartu.
Mytilus viridis, *Linn.* Tuticorin.
Modiola cinnamonea, *Lmk.* Pámban.
,, japonica, *Dunk.* Pámban.
,, Metcalfei, *Hanl.* Pámban.
,, perfragilis, *Dunk.* Pámban.
,, Trailli, *Rv.* Pámban.
,, tulipa, *Lmk.* Pámban, Silavaturai.
Lithodomus malaccanus, *Rv.* Pámban, Cheval.
,, antillarum, *Phil.* Pámban.
,, stramineus, *Dunk.* Pámban, Tuticorin.
Septifer bilocularis, *Linn.* Pámban.
Avicula fucata, *Gould.* Tuticorin.
,, inquinata, *Rv.* Tuticorin, Muttuwartu.
,, margaritifera, *Linn.* Tuticorin.
,, radiata, *Pease.* Tuticorin.
,, zebra, *Tuticorin.* Mimics the short lateral ramuli of the hydroid (*Aglaophenia urens*) to which it is attached.
Malleus vulgaris, *Lmk.* Pámban.
Pinna, sp. Pámban.
Arca Kraussi, *Phil.* Pámban, Tuticorin, Muttuwartu, Cheval.
,, symmetrica, *Rv.* Pámban, Tuticorin, Cheval.
,, (Acar) divaricata, *Sow.* Tuticorin.
,, (Anadara) granosa, *Linn.* Pámban, Kilakarai, Dutch Bay.
,, (Barbatia) decussata, *Sow.* Pámban.
,, (,,) fusca, *Brug.* Pámban, Muttuwartu.
,, (,,) lima. *Rv.* Tuticorin, Muttuwartu.
,, (Parallelopipedon) tortuosa, *Linn.* Pámban, Tuticorin.
,, (Scapharca) inæqualis, *Brug.* Pámban, Tuticorin, Dutch Bay.
Pectunculus angulatus, *Lmk* Muttuwartu.
,, Taylori, *Ang.* Pámban, Tuticorin, Cheval, Dutch Bay.
Limopsis Belcheri, *Ad. & Rv.* Pámban.
Nucula mitralis, *Hind.* Dutch Bay.
Leda mauritiana, *Sow.* Pámban, Tuticorin, Karaitivu, Dutch Bay.

Pecten Layardi, *Rv.* Pámban.
,, porphyreus, *Chemn.* Pámban.
,, singaporensis, *Sow.* Muttuwartu.
,, speciosus, *Rv.* Muttuwartu.
,, tendineus, Tuticorin.
,, varius, *Linn.* Pámban.
,, (Pallium) plica, *Linn.* Pámban.
,, (Pleuronectia) pleoronectes, *Linn.* Muttuwartu.
,, (vola) pyxidatus, *Born.* Tuticorin.
Lima orientalis, *Ad. & Rv.* Pámban.
,, squamosa, *Lmk.* Pámban, Cheval, Karaitivu, Muttuwarta.
Spondylus Layardi, *Rv.* Pámban.
Vulsella lingulata, *Lmk.* Pámban, Kilakarai.
,, rugosa, *Lmk.* Pámban.
Ostrea crista galli, *Linn.* Pámban.
,, hyotis, *Linn.* Tuticorin.
,, (Alectryonia) folium, *Linn.* Pámban.

BRYOZOA.

For the identification of the following small collection of Bryozoa I am indebted to Mr. R. Kirkpatrick of the British Museum, Natural History.

a. Encrusting or growing on Pearl Oysters.

1. *Cheilostomata.*

Scrupocellaria, sp.
Nellia oculata. *Busk.*
Steganoporella magnilabris, *Busk.*
Microporella (Adeonella) coscinophora. *Reuss,* var. Also found growing on coral-rock.
Lepralia depressa. *Busk.*
,, turrita. *Smitt. ?*
Smittia reticulata. *J. Macgillivray ?* var.
,, rostriformis. *Kirkpatrick ?* var.
Schizoporella cucullata. *Busk. ?*
,, unicornis, *Johnst.*
Cellepora albirostris, *Smitt.*

2. *Cyclostomata.*

Idmonea atlantica, *Forbes,* var.
,, n. sp. (?). Also found in crevices of coral.

b. Other Bryozoa.

Flustra foliacea, *Linn.* Foliaceous, and encrusting phanerogams on Ceylon pearl-banks.

Biflustra (Membranipora), savartii. *Audouin.* Massive, and encrusting Gorgoniæ. Rámésvaram island.

Lepralia gigas, *Hinks.* Eschara form. Rámésvaram Island.

Cribrilina radiata, *Moll.* var.

,, innominata. *Couch.*

TUNICATA.

Ecteinascidia thurstoni, *Herdman.*

A single specimen of this social ascidian, composed of a large number of ascidiozooids united together by a delicate branched stolon, which was fixed to the stem of a hydroid zoophyte, was brought up by my divers during one of my visits to Râmésvaram island, and kept alive for some days in the aquarium. The specimen was sent to Professor Herdman, by whom it has been described [32] as a new species closely allied to *Ecteinascidia turbinata*, Herdm. from Bermuda.

PISCES.

The following list comprises those species of fishes which I have either recorded or preserved during my visits to Tuticorin or Pámban on the Madras coast of the gulf of Manaar, which latter place I made my head-quarters while exploring the coral reefs which fringe the shores of Rámésvaram and the neighbbouring islands. These visits have always been made during the months of July and August, so that my examination of the fish fauna has been confined to a very limited period of the year, and it will doubtless be found, on more extended research to, vary according to the season or monsoon.

The most characteristic feature of the fauna, as contrasted with that of other parts of the coast of the Madras Presidency, is the prevalence of the so-called 'coral fishes' (*Chætodon*, *Heniochus*, *Pseudoscarus*, *&c.*), for the most brightly coloured fishes which abound over the reefs, and feed either on the small delicate marine invertebrates which swarm on the living corals, or, if their teeth are adapted

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[32] *Trans. Biol. Soc. Liverpool*, vol. v, 1891.

for the purpose, on the soft parts of mollusc, which they extract by gnawing or boring holes into the hard substance of the shell. As stated by Haeckel,[33] an explanation of the bright colouring of the fishes is found in the Darwinian principle, that the less the predominant colouring of any creature varies from that of its surroundings, the less likely it is to be seen by its foes, the more easily it can steal upon its prey, and the more it is fitted for the struggle for existence.

Conspicuous by their abundance were several species belonging to the family Sclerodermi, including *Balistes* (file or trigger fish), whose jaws are armed with sharp teeth, and which are said to be injurious to the pearl fishery by preying on the pearl oyster. Present, too, in great numbers, were several species of the family gymnodontes, *Tetrodons* (globe or frog fishes), including the beautifully marked little *T. margaritatus*, and *Diodons*, which have a bad reputation among the natives as being very poisonous.

Many of the brightly coloured fishes were preserved by the process, devised by Mr. A. Haly, Director of the Colombo Museum, which consists in cutting the fish in half by a medium longitudinal section, clearing away the bulk of the flesh, immersing for some days in a gum, glycerine, arsenic mixture[34] and finally mounting in pure glycerine. Specimens preserved in this way in 1888 still (1893) retain many of their brilliant hues, and of some of them paintings, accurate as regards colour, could still be made.

ELASMOBRANCHII.

(Sharks and Rays.)

CARCHARIIDÆ.

Carcharias. The young of several species commonly met with in the fish markets.
Zygæna malleus, *Shaw*. Pámban, Tuticorin.

SCYLLIIDÆ.

Stegostoma tigrinum, *Gmel.* Tuticorin.
Chiloscyllium indicum, *Gmel.* Tuticorin.

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[33] *A Visit to Ceylon*, Eng. Trans., 1883.
[34] Gum, 1 oz., glycerine, 1 oz., arsenious acid, $1\frac{1}{2}$ gr., water, 1 oz.

PRISTIDÆ (SAW FISHES).

Pristis cuspidatus, *Lath.* A specimen 18 feet in length brought on shore at Tuticorin in 1887.

RHINOBATIDÆ.

Rhinobatus granulatus, *Cuv.* Tuticorin.

TORPEDINIDÆ.

Narcine timlei, (*Bl. Schn.*). Pámban.

TRYGONIDÆ.

Trygon sephen, (*Försk*). Tuticorin.
,, uarnak, (*Försk*). Pámban, Tuticorin.
Pteroplatea micrura, (*Bl. Schn.*). A single female with twins *in utero* obtained at Pámban.

MYLIOBATIDÆ.

Myliobatis nieuhofii, (*Bl. Schn.*). Pámban.

TELEOSTEI (BONY FISHES).

MURÆNIDÆ (EELS).

Muræna tessellata, *Richardson.* Pámban, Tuticorin.
,, undulata, (*Lacép*). Tuticorin.

SILURIDÆ.

Arius thalassinus, (*Rüpp.*). Pámban, Tuticorin.

CLUPEIDÆ (HERRINGS).

Pellona leschenaultii, *Cuv. & Val.* Pámban.

SCOPELIDÆ.

Saurida tumbil, (*Bloch.*). Pámban.

SCOMBRESOCIDÆ.

Hemiramphus xanthopterus, (*Cuv. & Val.*). Pámban.

PERCIDÆ (PERCHES).

Lates calcarifer, (*Bloch.*). Pámban, Tuticorin. The "*cock-up.*" Largely eaten by Europeans in Calcutta under the name of *begti.*
Serranus boenack, (*Bloch.*). Tuticorin.
,, diacanthus, *Cuv. & Val.* Pámban.
,, hexagonatus, (*Bl. Schn.*). Pámban.
,, hoevenii, *Bleeker.* Pámban.
,, fasciatus, (*Försk*). Pámban.
,, salmoides, (*Lacép*). Tuticorin.
Lutjanus annularis, (*Cuv. & Val.*). Pámban.
,, decussatus, (*Cuv. & Val.*). Pámban.
,, fulviflamma, (*Försk*). Pámban.
,, rivulatus, (*Cuv. & Val.*). Pámban, Tuticorin.
,, roseus, *Day.* Pámban.
Therapon quadrilineatus, (*Bloch.*). Pámban.
,, theraps, *Cuv. & Val.* Pámban.
Pristipoma hasta, (*Bloch.*). Pámban.
Diagramma crassispinum, *Rüpp.* Pámban, Tuticorin.
,, cuvieri, (*Bennett*). Pámban.
,, griseum, *Cuv. & Val.* Pámban, Tuticorin.
Scolopsis vosmeri, (*Bloch.*). Pámban, Tuticorin.
Apogon auritus, *Cuv. & Val.* Tuticorin.
,, calosoma, *Bleeker.* Pámban.
,, thurstoni, *Day.* Pámban.
Chilodipterus quinquelineatus, *Cuv. & Val.* Pámban.
Gerres oyena (*Försk*). Pámban.

SQUAMIPINNES.

Chætodon auriga, *Försk.* Pámban.
,, collaris, *Bloch.* Pámban.
,, vagabundus, *Linn.* Pámban.
Heniochus macrolepidotus, *Linn.* Pámban.
Drepane punctata, (*Gmel.*) Pámban.
Scatophagus argus, (*Bloch.*) Pámban, Tuticorin.

MULLIDÆ (RED MULLETS).

Upeneoides tragula, (*Richardson*). Pámban, Tuticorin.
Upeneus indicus, (*Shaw*). Pámban.

SPARIDÆ (BREAMS).

Lethrinus karwa, *Cuv. & Val.* Tuticorin.
,, nebulosus, (*Försk*). Pámban.
Chrysophrys berda, (*Försk*). Tuticorin.
Pimelepterus cinerascens, (*Försk*). Pámban, Tuticorin.

SCORPÆNIDÆ.

Pterois miles, (*Bennett*). Pámban.

TEUTHIDIDÆ.

Teuthis marmorata, (*Q. & G*). Tuticorin.
,, oramin, *Günth.* Pámban, Tuticorin.

BERYCIDÆ.

Holocentrum rubrum, (*Försk*). Pámban, Tuticorin.

KURTIDÆ.

Pempheris malabarica, *Cuv. & Val.* Tuticorin.

SCIÆNIDÆ.

Sciæna maculata, (*Bl. Schn.*). Tuticorin.

ACANTHURIDÆ (SURGEONS).

Acanthurus gahm, *Cuv. & Val.* Pámban, Tuticorin.
,, triostegus, (*Linn*). Pámban.
,, velifer, (*Bloch*). Pámban.

CARANGIDÆ (HORSE MACKERELS).

Caranx gallus, (*Linn*). Pámban, Tuticorin.
,, hippos, (*Linn*). Tuticorin.
,, ire, (*Cuv. & Val*). Pámban.
,, rottleri, (*Bloch*). Tuticorin.
,, sansun, (*Försk*). Tuticorin.
,, speciosus, (*Gmel.*). Pámban.
Platax teira, (*Försk*). Pámban.
Lactarius delicatulus, *Cuv. & Val.* Pámban.
Equula edentula, (*Bloch*). Pámban.

SCOMBRIDÆ (MACKERELS).

Echeneis remora, *Linn.* Tuticorin. Crushed shells of the pearl oyster, and pearls have been found in the stomach.
,, naucrates, *Linn.* Tuticorin.

TRACHINIDÆ.

Sillago sihama, (*Försk*). Tuticorin. Called "whiting" by Europeans.

GOBIIDÆ (GOBIES).

Gobius bynoensis, *Rich.* Tuticorin.
,, citrinus, (*Rüpp.*) Tuticorin.
Periophthalmus koelkreuteri, (*Pall.*) Pámban.
Boleophthalmus boddaerti, (*Pall.*) Pámban.

BLENNIIDÆ.

Salarias marmoratus, (*Benn.*) Tuticorin.

MUGILIDÆ (GREY MULLETS).

Mugil pœcilus, *Day.* Tuticorin.
,, cunnesius, *Cuv. & Val.* Tuticorin.
,, speigleri, *Bleeker.* Pámban.

CENTRISCIDÆ.

Amphisile scutata, (*Linn*). Pámban.

GLYPHIDODONTIDÆ.

Glyphidodon antjerius, *Cuv. & Val.* Tuticorin.
,, cælestinus, *Cuv. & Val.* Pámban.
,, notatus, *Day.* Pámban.
,, sordidus, (*Forsk.*) Pámban.
Tetradrachmum aruanum, (*Linn.*) Tuticorin.
Amphiprion sebæ, *Bleeker.* Pámban.

LABRIDÆ (WRASSES).

Chilinus chlorurus, (*Bloch*). Pámban.
Platyglossus dussumieri, (*Cuv. & Val.*) Pámban.
Pseudoscarus chrysopoma, (*Bleeker*). Pámban, Tuticorin.
,, rivulatus, (*Cuv. & Val.*) Pámban.

PLEURONECTIDÆ (FLAT FISHES).

Plagusia marmorata, *Bleeker.* Pámban.
Cynoglossus macrolepidotus, (*Bleeker.*) Pámban.

SYNGNATHIDÆ (PIPE FISHES).

Syngnathus serratus, *Temm. & Schleg.* Pámban, Tuticorin.

SCLERODERMI.

Balistes mitis, *Ben.* Pámban. File Fish.
,, vetula, *Linn.* Tuticorin. File Fish.

Triacanthus strigilifer, *Cantor*. Pámban.
Ostracion cornutus, *Linn*. Pámban. Coffer Fish.
,, nasus, *Bloch*. Pámban. Coffer Fish.
,, turritus, *Försk*. Pámban. Coffer Fish.

GYMNODONTES.

Tetrodon hispidus, *Bloch*. Pámban.
,, margaritatus, *Rüpp*. Pámban.
,, immaculatus, *Bl. Schn*. Pámban.
Diodon hystrix, *Linn*. Pámban.
,, maculatus, *Günth*. Pámban.

LEPTOCEPHALUS, sp.

As regards the curious pellucid leptocephali, of which I have obtained a few specimens in the gulf of Manaar, and a large number from the meshes of the fishermen's nets at Gopalpur, where they are known as sea-leeches, Dr. Günther says: [35]

"We must come to the conclusion that these leptocephatids are the offsprings of various kinds marine fishes, representing, not a normal stage of development (larvæ), but an arrest of development at a very early period of their life; they continue to grow to a certain size without corresponding development of their internal organs, and perish without having obtained the characters of the perfect animal."

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[35] *Introduction to Study of Fishes*, 1880, pp. 179–182.